ANNALS

OF

SURGERY

A MONTHLY REVIEW OF SURGICAL SCIENCE AND PRACTICE

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VOLUME XCII

JULY—DECEMBER, 1930

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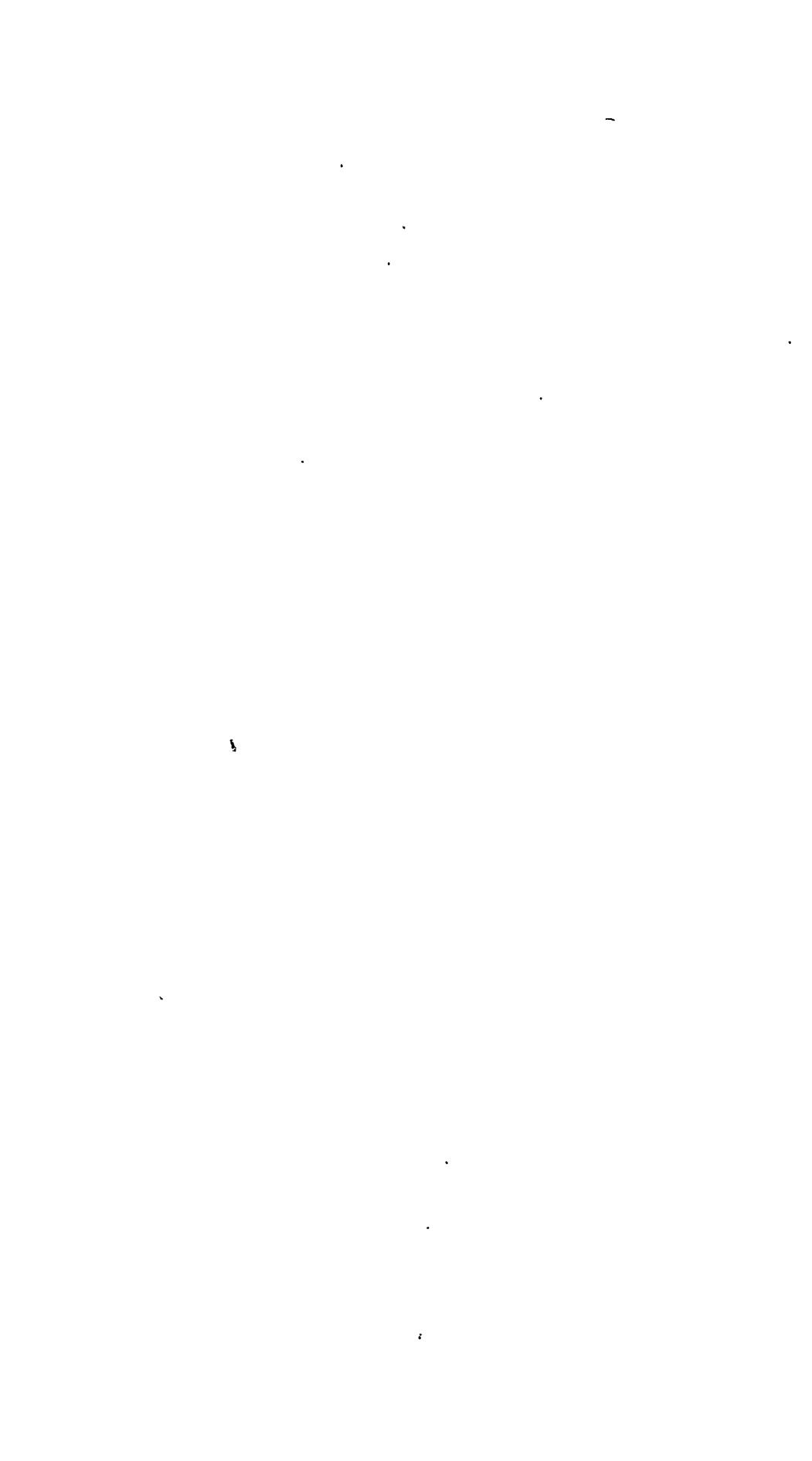
ON THE CAUSES OF POST-OPERATIVE DEATHS*

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On this occasion, when so many American colleagues are honoring Lund and its clinics with a visit, it appears appropriate to give a short survey of the post-operative deaths at the Lund Surgical Clinic. Respecting the material it may be mentioned by way of introduction that the annual number of clinic patients during recent years has been about or a little more than 3000, the yearly number of clinical operations about 2000 and the average number of resident patients roughly 200. This address gives a classification of the post-operative deaths at the Lund Surgical Clinic during the period 1922–1928, *i.e.,* during the last seven years.

Over fifteen years ago I published in *Bruns Beiträge*[1] a similar study of the operative mortality at the Lund Clinic for the years 1906–1910, which study, however, followed partly other lines. In a contribution to *Zentralbl. f. Chirurg.*[2] an account was given on the same lines as here, though this covered a smaller number of cases than the present study.

As a post-operative death *every* case has been classed that was operated on at the clinic and that died at the clinic after surgical intervention, thus also including, for instance, a cancer of the stomach where a palliative gastro-enterostomy was made and where for humane reasons the patient was allowed to remain at the Clinic and died there after about three months *cachectio modo*. A few of these post-operative deaths are therefore only post-operative in the sense that the patient had undergone an operation, without the lethal issue of the case having any causal connection with the operation undergone. From a strictly scientific point of view these cases ought not to have a place in the collection, but, for purely practical reasons, they are none the less included, as otherwise it would be difficult to draw a limit and the result might easily be a somewhat arbitrary inclusion or exclusion of some of the cases. Thus, then, *all* who died at the Clinic following an operation are included. As will be seen from the tables given below, an attempt has been made to bring all the fatal cases within certain groups in order to give a more comprehensive view of the real causes of death in the operative material of the Clinic.

Quite naturally, several lethal factors compete with one another in a

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* Address before the members of the Inter-State Post-Graduate Medical Association of North America, June 14, 1929.

certain number of cases. Classification may then be difficult and at times seems rather arbitrary. The cases have been placed in that group where the essential cause of death was to be sought. I would expressly stress that in doing this I have also endeavored as objectively as possible to refer the cases to the groups especially disagreeable to surgeons. If, in a collection of this kind, one consciously or unconsciously seeks in the least degree to protect the surgery or oneself, the figures will quite naturally present a more or less false picture.

What shape the operative mortality takes at a surgical clinic depends of course on several different circumstances: the proportion between the more risky major operations and the minor ones, the proportion between operations of "pure" cases and acute infections, the relative number of bad, very advanced cases in the material of, for instance, peritonitis, septicopyæmia, cancer and others. A large central hospital generally has a relatively larger number of cases with uncertain or bad prognosis than a smaller institution. Further, it is evident that such factors as the operator's conscientiousness, experience and technical skill play a certain part, as also undoubtedly his disposition and temperament: a bold and energetic surgeon operating on wide indications, who frequently attempts major radical operations and in general does not shrink surgical measures in more or less desperate situations, will most likely get a larger number of post-operative deaths than the conservative surgeon, who is more cautious and operates on stricter indications. Hence the operative mortality is influenced by many different factors, and the absolute mortality figures are not therefore always *in et per se* of so great interest. A critical analysis of the causes of death, on the other hand, is always of value.

Before presenting the classification of all the post-operative deaths for these seven years, I will first tabulate the figures from some rather large and important groups of operations within different branches of surgery and give particulars of the causes of death.

Included here are:

1. Operations for brain tumor, both palliative (the majority) and radical.
2. Operations for exophthalmic goitre, during recent years mostly subtotal strumectomy.
3. Operations for gall-stone and its complications: cholecystitis, peritonitis, choledocholithiasis, cholangitis. Cholecystectomy (in most cases), cholecystostomy (in a few cases), choledochotomy.
4. The appendicitis material.
5. Operations on kidney or ureter for calculus, tuberculosis, tumor, hydronephrosis, pyonephrosis, rupture of kidney.
6. Operations for prostatic hypertrophy. Prostatectomy (all transvesical).

During this period seventy-nine cranial trepanations were performed for *brain tumor* (cerebral and cerebellar) with twenty deaths. In sixty-eight cases (fifteen deaths) the operation was Cushing's decompression trephining or an exploratory trephining, possibly with puncture or a test excision

of brain; in eleven cases (five deaths) the tumor was completely or partially removed. Patients suffering from brain tumor are often frail and delicate operation subjects and, when operation is absolutely indicated and is the ultimum refugium, the mortality here is rather high. As indicated in the table, three died from pneumonia, one from pulmonary embolism, one from

TABLE I

Operations for Brain Tumor........ 79		Operations for Exophthalmic Goiter. 199	
Deaths after Operation 20		Deaths after Operation 14	
From the Brain Tumor (2 weeks after operation).....................	1	Acute Post-operation Hyperthyroidism.....................	8
Pneumonia......................	3	Pneumonia......................	4
Pulmon. Embolism..............	1	Uncertain Cause of Death........	2
Coma Diabetica................	1		
Infection......................	2		
Hæmorrhage into the Tumor Cavity	1		
Too Bad General Condition or Uncertain Cause.................	11		
Operations for Gall-Stones.......... 457		**Operations for Appendicitis........ 2192**	
Deaths after Operation 54		Deaths after Operation 75	
Brain Apoplexy.................	1	Peritonitis......................	45
Pneumonia......................	10	Ileus by Adhesions.............	7
Pulmon. Embol. Thromb.	12	Perforating Distention Ulcer......	1
Cholemic Hæmorrhage...........	2	Phlegmon of the Stomach........	1
Peritonitis......................	6	Cardiosclerosis.................	1
Hepatic Abscess or Cholangitis.....	3	Pneumonia......................	9
Acute Pancreatitis...............	4	Pulmon. Embolism..............	9
Probably Insufficiency of Liver.....	7	Pulmon. Tbc.	1
Acute Dilatation of Stomach.......	1	Hæmophilia....................	1
Surgical Technical Causes.........	2		
Bad General Condition...........	1		
Uncertain Cause................	5		
Kidney Operations................. 266		**Prostatectomy.................... 170**	
Deaths after Operation 24		Deaths after Operation 22	
Tbc. Meningitis................	1	Acute Psychosis................	1
Pulmon. Tbc.	1	Cardiosclerosis.................	1
Myocarditis	2	Pneumonia......................	5
Pneumonia......................	1	Pulmon. Embolism..............	2
Pulmon. Embolism..............	2	Surgical-Technical Cause........	1
Post-operative Hæmorrhage.......	2	Hæmorrhage (Mainly)...........	3
Infection......................	2	Infection......................	3
Uræmia.......................	8	Pyelonephritis, Uræmia.........	6
Parotitis......................	1		
Tumor-Cachexia................	1		
Complic. Disease................	3		

diabetes, one probably from hæmorrhage as proximate cause and two from infection (in one case with tamponade for severe, stubborn hæmorrhage and death from meningitis after eight days; in the other case with leakage of cerebrospinal fluid into the wound and deaths after three and one-half weeks). No fewer than nine of the other cases died within three days after the operation: a boy of nine years with glioma of the cerebellum died on the

operating table, four others died within one day and five on the second and third day. Several of these patients were dull and debilitated before the operation and were too bad for even palliative surgical treatment, others died rather suddenly and unexpectedly, *e.g.*, two after extirpation of an auditory nerve tumor. The chief post-mortem finding in the non-radically operated cases was usually the brain tumor itself, sometimes a more or less intensive internal hydrocephalus, sometimes a certain degree of hæmorrhage in the region of the operation, the import of which was often difficult to judge. At autopsy of these cases it often proved troublesome to determine the causes of death.

The table shows 199 *strumectomies for exophthalmic goitre* with fourteen deaths: eight of them in acute post-operative hyperthyroidism (during the last four years we have had four such deaths, despite the fact that these years practically all the serious cases of exophthalmic goitre had been pre-operatively treated with Lugol's solution). In four cases the cause of death is pneumonia, although local anæsthesia was invariably used. In two cases the cause is rather uncertain.

Next we find 457 *operations for gall-stone* with fifty-four deaths. Pulmonary embolism and pneumonia play here a very large part as cause of death (in twenty-two cases); peritonitis figures prominently in the severe cases of cholecystitis with possible perforation (in six cases). In four cases the causes of death was concurrent acute pancreatitis. Several deaths in the gall-stone group must, despite necropsy, be denoted as uncertain; some of the cases diagnosed as "Probably Insufficiency of Liver" are also rather uncertain. We lose here and there complicated gall-stone cases after operation, especially debilitated patients with icterus, where we cannot determine why the patient dies.

The *appendicitis material* comprises 2192 cases with seventy-five deaths, *i.e.*, a mortality of 3.4 per cent. (within this group the figures are so large that computation in percentages is justified). Peritonitis is as a matter of course the main cause of death (in forty-five cases). Next come pulmonary embolism and pneumonia with nine deaths each. Further there are here a number of cases with ileus by adhesions where we were unable to pull the patient through.

The table shows 266 *kidney and ureter operations* with twenty-four deaths due to rather varying causes. Uræmia represents the largest group (most of these were in a uræmic condition before the operation). The lung complications play a rather insignificant part as cause of death within this group.

One hundred and seventy *prostatectomies* for prostate hypertrophy have twenty-two deaths. As the table shows, the principal causes of death are pyelonephritis and uræmia, pneumonia, infection and hæmorrhage. Pulmonary embolism has here only two cases to its account.

The total number of post-operative deaths at the Lund Surgical Clinic during the seven-year period 1922–1928 was 856. In Table II, below, these 856 cases are distributed among nine different groups. As will be seen, the

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table with its grouping is not drawn up on any uniform logical principle, but purely according to practical clinical conditions.

As a commentary to the table it may be mentioned that Group 2, "Bad General Condition," contains all cases where the bad general condition of the patient, senile marasmus, intense arterio- or cardiosclerosis, myocarditis, diabetes, tuberculosis or concurrent malignant tumor in the case of patients operated on for other complaints, for bad Basedow condition, etc., was the *main* cause of death.

Under the head "Technically Faulty or Incomplete Operation" are included, besides the cases where surgical faults had manifestly been committed, such cases as those where autopsy showed that an operation performed in another way would have probably given a successful result.

As regards the group "Post operative Infection"—a serious group for surgery and surgeons—it may be remarked that nineteen out of the thirty-

TABLE II

Cause of Death	1922	1923	1924	1925	1926	1927	1928	Total
1. Primary Disease or the Lesion Itself	53	48	55	55	56	49	66	382
2. Bad General Condition	11	5	11	14	13	9	12	75
3. Errors in Diagnosis, Incorrect Expectant Treatment	1	—	4	1	2	1	2	11
4. Technically Faulty or Incomplete Operation	5	11	5	4	2	7	3	37
5. Post-operative Infection	7	4	7	4	3	4	3	32
6. Special Post-operative Complications	5	16	12	13	17	10	8	81
7. Pneumonia, Pulmon. Abscess, Bronchitis	18	20	25	19	26	17	20	145
8. Pulmonary Embolism, Thrombosis	16	5	7	10	17	12	11	78
9. Uncertain Cause (often despite autopsy)	3	1	—	5	3	2	1	15
Total	119	110	126	125	139	111	126	856

two cases belonging here have reference to resections or anastomoses on the stomach, mostly for cancer ventriculi, or on the intestine, often for cancer coli. The remaining thirteen operations where I have considered that post-operative infection ought to be recorded as the chief cause of the unsuccessful issue—sometimes the cases are rather complicated and several circumstances have coöperated to this result, eight of the cases are patients with malignant tumor—are as follows: Two cases of trephination for brain tumor (in one of these a cerebrospinal fistula after the operation), two resections of the lower jaw for cancer, one extirpation of large ulcerated epithelioma on a senile person, one cholecystectomy with long complicated after-course, one exploratory laparotomy for inoperable high rectal cancer (uncertain how far peritonitis or intestinal obstruction is more responsible for exitus; no autopsy), one cancer-recti amputation, one bilateral exploratory kidney operation on child with renal tuberculosis, one sectio alta and subsequent urethrotomy in a complicated case, one sectio alta for a large infiltrating and decomposing cancer-tumor of the bladder, and two prostatectomies.

Under "Special Post-operative Complications" are included such dis-similar conditions as acute psychosis, cerebral hæmorrhage, tubercular menin-gitis, diphtheria, gastric ulcer or cholemic hæmorrhage, liver insufficiency, circulus vitiosus, acute diltation of stomach, post-operative ileus, pyelo-nephritis, uræmia, etc.

A comparison of the figures tabulated for the different years will show that although the deaths certainly distribute themselves among the different groups with a certain variation, yet on the whole they do so with a certain uniformity year after year, *e.g.*, the annual number of post-operative deaths in pneumonia and from pulmonary embolism. The pulmonary embolism mortality is relatively high in our Lund material, seventy-eight deaths during seven years, *i.e.*, a yearly average of eleven (on about 2000 operations). A comparison with the figures given in my previously mentioned paper from 1912 shows that the number of post-operative deaths from pulmonary embol-ism has increased at our Clinic during the last fifteen to twenty years.

TABLE III

Cause of Death	1922	1923	1924	1925	1926	1927	1928
Primary Disease or the Lesion Itself (1 in Table II)......................	46%	44%	44%	46%	41%	45%	53%
Unsatisfactory Indications for Opera-tion (2–3 in Table II)	10%	5%	12%	12%	11%	9%	11%
Unsatisfactory Operation or Special Post-operative Complications (4–6 in Table II)......................	15%	28%	19%	18%	16%	19%	11%
Post-operative Pulmonary Complica-tions (7–8 in Table II).............	29%	23%	25%	24%	32%	27%	25%

If, to get a better collective view, the different causes of death recorded in Table II are assembled into four large groups—which, however, will be rather schematic in certain points—and the post-operative deaths with a known cause, computed in percentages for each year, are divided among these four groups, Table III is obtained.

The percentage figures in this synoptical table show certain variations for the different years, but in the main exhibit good, in part surprisingly good, agreement. This table discloses that during these last seven years at the Lund Surgical Clinic *almost one half* (mostly 44–46 per cent.) *of all the patients that succumbed after operation had died from the primary disease or the lesion itself or some complication of it.* For these deaths surgery can hardly ever be held responsible. Out of the other half more than one half, *i.e., more than one fourth* (mostly 25–29 per cent.) *of the operation cases ending fatally, died from pulmonary complications: pneumonia and pul-monary embolism.* The remaining cases, *i.e., fully one fourth of all the oper-ative deaths* (mostly 25–30 per cent.), fall more immediately or directly to the account of surgery, having been due to *inaccurate or debatable indications*

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—the patient has for instance been in too bad a condition for the operation undertaken—*or to faulty technic or incomplete operation or to some special intercurrent operative complication.*

The question of the possibility and prospects of forcing down the number of post-operative deaths is manifestly a wide and important subject within present-day surgery, and one that concerns and is bound up with many different circumstances. On this point just a few words: With respect to the large group where the primary disease or the lesion itself is the lethal cause, it is a matter of course that injuries endangering life and, for instance, hopeless septic conditions will always occur. It should, however, be possible to get the mortality within this group reduced, at any rate to some extent, by improving the knowledge of the public itself in respect of certain morbid states, by laying still greater stress, in our training of medical aspirants, on the prognostic value of *early* diagnosis and *early* surgical treatment of certain diseases, as also by a good and intimate coöperation between medical practitioners and the surgical hospitals.

As regards the groups "Unsatisfactory Indications for Operation" and "Unsatisfactory Operation or Special Post-operative Complications," much will naturally depend on the individual surgeon's experience, knowledge, scrupulousness, judgment and technical skill, but we may also, more objectively, set certain hopes on an improved and more reliable study of organic function and on physiological investigations of possibly existent metabolic derangements, at least for *certain* groups of patients, preliminary to the proposed operation.

Most dismal of all at present is the group "Post-operative Pulmonary Complications" and here particularly pulmonary embolism. At most surgical clinics all over the world pulmonary embolism has probably occurred with increased frequency during the last twenty-five years. The often quite unexpected and unforeseeable occurrence of deaths from pulmonary embolism, their increased number and our, in the main, helplessness in the face of them, both prophylactically and therapeutically, make pulmonary embolism the greatest crux of present-day practical surgery.

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PULSATING EXOPHTHALMOS *

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Able publications on the subject of pulsating exophthalmos have appeared since Benjamin Travers [1] reported the first case in 1809. Attempt is not made here to trace the history and the bibliography to the present, but to report another, a very interesting type of case, which may serve as a basis for analyzing our knowledge as it applies to treatment.

In 1908, de Schweinitz and Holloway [2] found that 313 cases had been recorded during the first 102 years, and added sixty-nine more. Sattler's [3] report, comprehensive and complete, brings the review up to 1920. Locke, [4] in 1924, adds 131 cases. Jennings [5] in 1927 found 596 cases recorded, including one reported by himself. Since Jennings' article, we have been able, after careful search, to add twenty-one more cases, including five reported by one of us (Wheeler [6]), bringing the total number recorded in all languages, including our own case, to 617. The latest one recorded prior to our own, is that of Scotti [7] in March, 1929.

The average number of cases per year reported throughout the literature since 1813 is about five. Thus the disease is rare, yet one which the general surgeon nearly always, whether it be spontaneous or traumatic, is called upon to treat.

The details of treatment are by no means commonly accepted and so it is important that all cases be reported both to stimulate early d'agnosis and to approach standard treatment.

The case which is the occasion of the preparation of the following paper was observed in the period between March, 1929, and March 1, 1930. Its origin was traumatic, having been due to a fracture of the skull producing an arterio-venous communication between the right internal carotid artery and the cavernous sinus, culminating in an acute glaucoma. The treatment was first, digital compression of the right common carotid artery producing complete occlusion, and later, compression of the left, with partial occlusion becoming complete, and later enucleation of the right eye for glaucoma with result of apparent cure.

Case.—L. G., age forty-four years; single. Past history essentially irrelevant except that for some time she has occasionally had blurring of vision in the right eye, not corrected by glasses. Ophthalmologists have thought that this eye symptom was due to infection of ethmoid, sphenoid and frontal sinuses. At the time of her accident, she was about to undertake a further study of the sinuses, although recently she had not been especially troubled with catarrh. Her physician reported that she had had a rheumatic heart, probably with mitral stenosis, but not serious.

On the morning of March 18, 1929, about 9 o'clock, she was struck by a truck on

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* Read before the New York Surgical Society, March 12, 1930.

the street, receiving injuries to her head and left shoulder. She became unconscious for a short time; was taken to a drug store, whence she was removed by ambulance to the Presbyterian Hospital and first examined at 11:30 A.M. She had vomited before arrival and complained of nausea, headache, dizziness, pain across the eyes and across the back of left shoulder; and felt chilly. She had bled from her nose.

The combined physical examination of Dr. Charles A. Elsberg and the surgeon revealed an essentially healthy looking woman, rather pale but quiet and resting on her back. The surface was moderately cold, the eyes were closed with the upper lids prominent and purplish in color. The right eyeball protruded slightly and there was subconjunctival hæmorrhage. The pupils were equal, reacting sluggishly to light and accommodation. The movements of the eyeball were good in all directions. The fundi appeared normal with arteries and veins of normal size without hæmorrhages.

FIG. 1.—Patient before operation.   FIG. 2.—Patient before operation.

There was an abrasion on the left temporal region with marked swelling and œdema and a large hæmatoma over the left parietal region giving a central depression. A cracked-pot sound was not obtained. Fresh blood appeared in the external nares and in the mouth. The tongue protruded in the median line. There was no facial paralysis. The blood-pressure was 144/90. Pulse 80. Temperature 98.8°. Respirations 28. The heart and lungs were made out normal. There was tenderness over the spine of the scapula but no other evidence of fracture was found on the primary examination. The power in all her limbs was good and equal. The upper extremity reflexes were normal and equal. The lower extremity reflexes were also normal and equal except that the right Achilles was the more active. Abdominal reflexes, normal and equal. The cranial nerves were made out normal and there was no disturbance of sensation except over the left side of the head, which was tender.

Tentative Diagnosis.—Fracture of the left side of the vault and of the base of the anterior fossa of the skull. Fracture of the spine of the scapula. No evidence of gross intracranial lesion.

·The patient was carefully·watched, treated symptomatically,·the left arm bandaged to her side and that evening, a catheterized urine specimen showed little albumin and a few casts.

The next morning she felt better but had bad headache and pain in the left shoulder and arm.

Three days later there was marked swelling and protrusion of the conjunctiva in the upper and lower lids of the right eye with much pain in the right eye. At this time, examination by Doctor Wheeler was stated as follows:

"Exophthalmometric readings: right 22 millimetres; left 20 millimetres. A bruit synchronous with the pulse can be heard anywhere on the head or face, perhaps loudest in the temples. It can be heard distinctly over both globes. I could not convince myself that it was more distinct on the right side than on the left but subjectively it is heard only on the right. Patient has been conscious of a 'swish' with her heart beats during the past two or three days but it has not bothered her. In my opinion there is an arterio-venous communication in the cavernous sinus. I should expect the proptosis to increase and the symptoms to become more pronounced. Ligation of the common carotid artery and the creation of adhesions between the right upper and lower eyelids might be considered. I suggest compression of the right common carotid artery."

One week after the injury, the patient was very ill, with vomiting, anorexia, pain in the right orbital region and the sense of pulsation in the right side of head.

On this day marked pulsation of the right eyeball, synchronous with the heart beat, was detected on palpation and inspection. The bruit was still heard equally on both sides. On compression of either common carotid singly no decrease of the bruit was heard; but when both were compressed simultaneously it decreased.

On the same day, Dr. Charles A. Elsberg found the cornea sensitive to cotton; the pupil reacting sluggishly to light but the contraction not sustained. He also found no influence upon the pulsation of the eyeball by compression of the right carotid. He also concluded that the patient had an arterio-venous communication.

He felt the outlook gloomy unless a clot should form either spontaneously or after ligation. He felt the outlook for improvement after ligation of the right carotid was not good because of the fact that the pulsation continued even after compression of the vessel.

Three days after the injury, Dr. Ross Golden, röntgenologist of the Presbyterian Hospital, reported a transverse fracture of the left acromion process without displacement, a comminuted fracture of the neck of the scapula. The following ribs were fractured: the second, third, fourth and fifth on the left side. Films of the skull showed no evidence of fracture in the left temporo-frontal region. "The fracture line rises out of the floor of the anterior fossa. Another line appears to run upward and then downward through the margin of the orbit. The nasal bone appears to be fractured. The upper margin of the right orbit appears irregular but I am not sure that it was fractured. The right ethmoid region appears quite opaque as if there might be hæmorrhage in the cells."

April 5, nineteen days after the injury, the patient presented an increasingly distressing condition with headache every morning, extreme dryness of the mouth, absence of smell and taste, pain in right orbital and temporal region and a continuation of the exophthalmos, pulsation, "swish" and bruit. The bruit was not high pitched. She was completely dependent upon sedatives even for slight relief of distress. On this day, it was found that compression of the right common carotid artery caused disappearance of the subjective "swish," of the objective bruit and of the pulsation. After consultation, it was finally determined that·a definite step in treatment should consist of a few days of digital compression followed by careful ligation of this artery.

April 15, twenty-nine days after the injury.—During the preceding ten days, digital compression of the artery against the carotid tubercle was made by the day nurse beginning with five minutes and gradually increasing to fifteen minutes three times a day.

It apparently caused no unfavorable symptoms; yet the patient had become worse with vomiting, dehydration, thirst, dizziness, headache, photophobia and depression. There was paralysis of right external rectus muscle. On this day the right common carotid artery was ligated under local anæsthesia. One per cent novocaine was used to block the cervical plexus according to the technic of Labat and local infiltration into the site of operation. Local infiltration was used in the right thigh for the removal of a strip of fascia lata.

Procedure and Findings.—The artery was about .75 centimetres in diameter. After isolation of the artery, a small guarded clamp was applied slowly and left on for some thirty-five minutes, during which time Doctor Wheeler heard but a faint bruit, almost imperceptible, and no new symptoms were felt by the patient. It was agreed therefore that complete ligation was indicated and probably safe because of her relative youth, of the elasticity of the artery and because of the fact that very soon, if not then, a complete ligation would almost certainly be needed. During the operation the patient complained of thirst and especially of pain just below the right mastoid.

A six-centimetre oblique incision was made along a crease in the neck about opposite the upper border of the thyroid cartilage and deepened through the superficial layer of the deep fascia. An upper and lower flap were reflected and the sternomastoid muscle retracted backward. The carotid sheath was entered when the ansa-hypoglossi appeared. This was pushed upward and the vein retracted backward. The vagus nerve was easily avoided. The artery was gently elevated by means of a small right-angled ligature carrier.

While the clamp was in place a strip of fascia from the thigh, twelve centimetres long and one centimetre wide was removed by the Gallie technic. Part of this was then passed once around the artery and fixed to itself with three fine chromic sutures. It was then passed again and snugly fixed and finally a third time around and again sewed snugly around the artery. Redundant fascia was cut way. Difficulty was encountered in making the circular application of the fascia sufficiently tight to obliterate the pulsation. It almost succeeded but not quite. As a final step therefore, a doubled No. 2 chromic ligature was tightly tied around the artery just above the fascia; that this obliterated the lumen was proven because pulsation could not be felt above it, because the patient ceased to hear the "swish" and because the bruit became almost imperceptible. A small tube was left in the neck wound for oozing, to be removed next day.

The operation was done with deliberation in order to be fully observant of the effects of complete occlusion before the final ligature.

Three days after the operation: severe headache, probably due to brain anæmia; blood-pressure, low. "Swish" not felt by patient since operation. Bruit very faint. No visible pulsation but on deep pressure, faint pulsation of the right globe is felt. Exophthalmometer: right 21 millimetres; left 16 millimetres.

Seven days after operation, Doctor Elsberg found distinct left lower facial weakness of supranuclear type. The tendon reflexes in the left upper and lower extremities were more active than those on the right. There was double inexhaustible ankle clonus and double Babinski and Chaddock signs. These signs meant either increase of the size of the aneurism or a secondary softening in the right cerebral hemisphere.

Ten days after operation, Doctor Wheeler found less deviation of the right eye and improved motility. The veins of the globe were still dilated but no dilatation of veins of the lids. The bruit was much more distinct over the right globe than elsewhere and it seemed louder in the temple than during the first few days after ligation. Exophthalmometer: right 21 millimetres; left 18 millimetres.

April 28, thirteen days after operation, the "swish" again was felt. She was vomiting daily. Both eyeballs appeared more prominent and the bruit was again very loud.

Digital compression of the left common carotid artery almost, if not completely, eliminated the bruit. Compression of the left carotid was started April 27, twelve

days after the operation on the right, five minutes three times daily, increased five days later to ten minutes.

May 2, seventeen days after operation, ophthalmoscopic examination revealed slight dilatation of the retinal veins of the right eye with no other abnormal findings in the eye grounds.

May 4, nineteen days after operation, observations of Doctor Elsberg: "The left facial paralysis persists. The tendon reflexes in the left upper and lower limbs are still more active than those on the right; the double ankle clonus is now not as well sustained and easily exhaustible. Babinski and Chaddock signs still are present though less marked on the left but not elicited on the right side."

Conclusion.—The disturbances due either to the arterio-venous aneurism itself or secondary to the ligation of the carotid on the right are much less marked and the

FIG 3 —After operations   Artificial eye   Note scars
in neck

FIG. 4 —After operations   Artificial eye.
Note scars and enophthalmos.

right cerebral hemisphere is again adequately supplied with blood. Unfortunately the bruit has returned. Compression of the left carotid for five seconds caused an increase of the pain in the right side of the head, but the bruit to be heard over the right temporal region promptly disappeared. At present, careful compression of the left carotid for increasing periods was thought to be all that was permissible. If the slightest cerebral symptoms should occur during a period of compression, this was to be stopped at once.

May 19, 1929, thirty-four days after operation, observations by Doctor Wheeler: "Right eye: Eyelids; slight dilatation of veins. At margin of upper lid is a little varicosity. No œdema. Conjunctivæ: Veins markedly dilated. Pupil: slightly dilated and irregular in shape. It does not react to direct light. Movements: Considerably improved but still limitation of abduction. Interior: Retinal veins greatly dilated. Many hæmorrhages into retina, especially along dilated veins. No œdema. Left eye grounds normal. Exophthalmometer: right 20 millimetres; left 17 millimetres. Last evening

for the first time, the patient heard a musical squeaking sound which was timed with the pulse. The bruit can be heard faintly in the right temple, surely not as loud as at my last examination though still loudest over the right globe."

June 15, two months after the right ligation: The patient was miserable with headache, depression, occasional hysteria and dependent upon codeine and morphine. Thè "swish," or subjective bruit, was but rarely sensed and not a distressing symptom. The bruit was very distinctly heard, especially over the right globe. The conjunctiva of the right eye was œdematous and protruding, and the veins more dilated. The retina had more hæmorrhages. Central vision was involved by the hæmorrhages. The sixth nerve paralysis persisted. In the left eye, the veins of the bulbar conjunctiva were slightly dilated but this eye was otherwise normal.

Since the patient was in a most distressing state and not improving, despite a long period of left carotid compression, partial ligation of left common carotid artery was then decided upon.

June 19, 1929. *Operation.—Partial ligation of the left common carotid artery.* Novccaine was used for block and local anæsthesia. An obliquely transverse six-centimetre incision was made about at the level of the upper border of the thyroid cartilage in a natural crease opposite the right scar. The same technic was used as on the right side for exposure and delivery of the artery. A strip of "Baer's Membrane" (chromicized pig bladder) one-half centimetre wide was passed around the artery three times, securing it each time with very fine chromic catgut. The diameter of the artery was thus decreased by more than one-half and the pulsation above the partial occlusion was definitely less intense than that below. The membrane was friable so that the security of the ligature was doubted. Therefore over the membrane, a strand of No. 2 chromic catgut was tied but not sufficiently tight to increase the obliteration of the lumen. It was used merely for reinforcement. The wound was closed in layers without a drain.

During the ligation, careful observation was made to determine any subjective or objective signs of interference with the intracranial circulation. None were noted. The operation was done deliberately over a period of a little over an hour.

July 7, nineteen days after left carotid ligation: The headache and "swish" and bruit were less than at any time since before this operation. The headache was of a different type; in the top and back of the head, and she had nervousness, restlessness, emotionalism. It appeared that her symptoms might well be due to the withdrawal of morphine and codeine used for so many weeks. The eyeball did not pulsate. It was but faintly prominent so that the patient no longer had "pulsating exophthalmos" but had a faint bruit. Paralysis of the sixth nerve, congestion of the conjunctival vessels and faint vision in the right eye persisted. Pulsation in the neck, above the site of recent ligation of the left carotid could not be felt, so it was assumed that the left ligation had spontaneously become a complete occlusion.

July 20, thirty-one days following left carotid ligation: Codeine and morphine had not been used for more than two weeks. The past four days and nights had been very comfortable with little headache, limited to the vertex and occiput—no right eyeball headache. She was eating well. Her functions were essentially normal. She walked about the hospital and out of doors though somewhat unsteady on her feet. Simple sedatives were required for sleep and for the slight headache. Paralysis of the sixth nerve had disappeared, a good prognostic sign of the reduction in the size of the aneurism. She felt no "swish" and no bruit was heard anywhere except perhaps faintly over the right globe. No abnormal neurological signs were found. Exophthalmos and pulsation were now absent. There was dark red discoloration of the conjunctiva due to chronic passive congestion of the scleral vessels. The left pupil was normal. The right was irregular, pear-shaped, almost fixed. There was diplopia probably due to muscular weakness of the right eye. She read with the left eye and when awake wore spectacles with the right glass darkened. No pulsation was felt in either side of the

neck above the site of ligation, so it was assumed there was complete occlusion of each common carotid artery. Her spirits were good. Blood-pressure and urine remained normal.

Observations of Doctor Wheeler: "Exophthalmometer: right 20 millimetres; left 20 millimetres. In the right eye, dilatation of the veins of the bulbar conjunctiva persists. Pupil, as stated above. The fundus of the right eye shows no new hæmorrhages, with previous hæmorrhages in various stages of absorption. The patient can move the right eye a little beyond the mid-line in 'eyes right.' The bruit can be heard faintly over the right globe but nowhere else. No pulsation of the globe. The left pupil reacts well."

July 20, four months following the injury: The patient leaves the hospital with a trained nurse to visit in the country.

August 23, five months from the injury and about two months from the second ligation: The patient was returned on a stretcher to the hospital. She had done well for one week following her discharge when she began to have pain in the right eye, becoming very acute. A short time afterwards, she was seen by Doctor Wheeler, who made the diagnosis of acute glaucoma of the right eye. Despite the use of eserine and hot compresses, the tension of the eye could not be controlled and the pain became increasingly severe. Her condition on re-admission was that of marked prostration and stupor from large doses of morphine.

At this time, Doctor Kirby was asked to assume charge of the patient because of Doctor Wheeler's absence from town. His observations on her re-admission were as follows:

Right eye: congested conjunctival and deep vessels. Cornea hazy with œdema of its epithelium. Anterior chamber shallow. Pupil dilated and immobile. Interior not visible because of the haze of the media. Increased intra-ocular tension. Tension of right eye, 40; of left, 12. Exophthalmometer: right 23 millimetres; left, 25 millimetres.

Left eye: considerable chemosis of palpebral conjunctiva inferiorly. Congested conjunctival vessels. Cornea clear. Anterior chamber shallow. Iris clear. Pupil small but no reaction. Interior not seen. No bruit heard over either eye. No pulsation of eyeball and no "swish" has been heard by the patient since leaving the hospital.

Treatment.—Eserine 1 per cent every two hours; boric solution and hot compresses and symptomatic treatment.

On the same evening, on account of intense pain, Doctor Kirby performed a paracentesis of the right cornea. Aqueous humor escaped slowly, lowering intra-ocular tension. Temperature, pulse, blood count and urine essentially normal.

August 27, on account of persistent pain, and of intra-ocular tension and because the organ was hopeless for recovery of vision, we advised removal of the right eye.

August 28, Doctor Kirby, with local anæsthesia, enucleated the right globe. Pathological report upon the eye reveals nothing significant nor unusual.

September 6, nine days following the removal of the eye, Doctor Kirby reported that the left eye was as follows: Exophthalmometer 0.5, 22 millimetres, at 92. Fundus examination, marked cupping of the disc (physiological). Veins, moderately full. About one disc diameter from the margin of the papilla is a greenish-brown area suggesting an old hæmorrhage; but no suggestion of recent or old hæmorrhage elsewhere.

February 19, 1930: In October, the patient was fitted with an artificial eye and since that time has been comfortable and well in every way except for the absence of smell sensation, very faint taste sense and lack of normal energy. Her general habits and functions are essentially normal. Her weight is below what it used to be. She has no sensation of a "swish"; no bruit is heard and there is no pulsation in either eye. The right eye shows recession or enophthalmos. There are no neurological findings. The external jugular veins pulsate quite markedly with the heart beat. She is now doing part-time work and does a good deal of reading.

Discussion.—The diagnosis of pulsating exophthalmos was established by the cardinal features, subjective and objective bruit, exophthalmos, and pulsation of the eyeball.

It is not positive that there was an arterio-venous communication though this is the most probable lesion. Against it are the absence of a whistling type of bruit, of gross distention of the veins of the orbit, and of marked exophthalmos. In this case, the lids did not need surgical closure to prevent extreme protrusion. Blood from a nearby vein was not obtained for its oxygen content. This would have been the only positive evidence. It would be interesting, on future cases (and an easy step) to obtain a sample of blood for oxygen content from the internal jugular vein at the time of operation.

It may be that this patient had merely a simple aneurism of the internal carotid in the cavernous sinus.

It is noteworthy that at first only bilateral carotid compression decreased the bruit, whereas, twenty-nine days after the injury, before either operation, compression of the right obliterated it entirely. Thus, perhaps, some degree
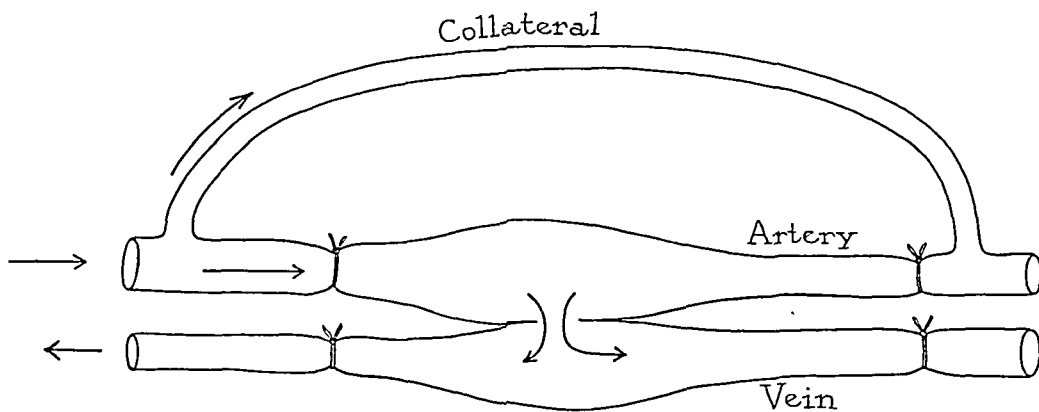
FIG. 5.—Quadruple ligation in arterio-venous aneurysm of an extremity.

of spontaneous obliteration of the aneurism had occurred. This finding increased the chance of improvement by ligation.

The pre-operative compression was easily made by a nurse, guided by the effect upon the "swish" and instructed how to suspect trouble. It caused little discomfort to the patient, although an added annoyance. The artery was compressed backward and inward against the transverse processes.

In the first operation (on the right side), simple wrapping of the fascia lata about the vessel was not difficult but tightening was awkward and indeed failed of occluding the vessel completely. Tying one or more thin fascial strips about the artery would have been easier and just as effective in providing a secure, permanent, occluding substance. The fascial wrapping plus the chromic ligature evidently worked well enough in this case.

The right carotid occlusion was followed by a slight degree of damage (probably a narrow escape) to the right cerebrum. There was none noted following the left ligation, which, however, was at the start only a partial occlusion. In the second (the left) operation, "Baer's Membrane" offered the same trouble of securing it after it had been wrapped about the vessel.

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It was not only difficult but too friable to fix securely. This substance does not appear to be suitable to be used as a tied ligature. Complete occlusion occurred in the left artery and was noted, first, eighteen days after the partial occlusion by the "Baer's Membrane."

Acute glaucoma is not a common, but a recognized sequel of this disease. While the loss of the affected eye is deplored, the patient is fortunate in having a good remaining eye.

The patient has been cured, apparently, and has been comfortable since September; now about five and one-half months. The injury was nearly a year ago.

The main interest in the treatment of a pulsating exophthalmos centers around the dangers of carotid occlusion.

A few cases are reported as resolving spontaneously and a few following simple arterial compression. A few have responded to operation limited to the orbital vessels in which there is no essential danger. But the great majority of patients go unrelieved without partial or complete occlusion of the common or of the internal carotid artery, of one or both sides.

The dangers are mainly two-fold; either death or permanent cerebral damage, such as hemiplegia, partial or complete. Writers vary, but one might state fairly that there is about 10 per cent. mortality and in those that survive, 10 per cent. morbidity. Damage is due to failure of adequate collateral circulation which is mainly through the circle of Willis. Arteriosclerosis increases the dangers and so generally speaking, the younger the patient, the less the danger.

The factors tending to minimize these dangers of occlusion are mainly complete rest in bed, a period of pre-operative compression of the common carotid artery and some method of partial or of gradual complete occlusion. Recently, Holman[8] has emphasized the added safety of combining internal jugular vein ligation with carotid occlusion for arterio-venous communication.

The surgeon confronted with the problem of operative treatment must decide certain points.

A. The selection of the vessel or vessels to be occluded.

The common carotid has been the one most frequently used and many successful cases have been recorded following its use. A few successful bilateral occlusions of this artery are also on record. There are some theoretical disadvantages in the use of the common as compared with the internal carotid artery. The external carotid artery has a free anastomosis with its fellow of the opposite side which may result in a retrograde stream down the external carotid and up the internal carotid on the side on which the common carotid is occluded. If this occurs then the aneurism again becomes subject to refilling through the original route. The common carotid being a larger artery requires more substantial means of occlusion. Conversely, a ligature is more likely to give way before the pressure and fail to occlude or on the other hand to cut through to cause secondary hæmorrhage.

The most telling evidence against the common carotid and in favor of the internal are the statistics of Sattler[3] and of Locke.[4] In searching the records they, independently, found better results following ligation of the internal carotid artery. Grouping spontaneous and traumatic cases of pulsating exophthalmos together, Sattler found that after primary ligation of the internal carotid 67 per cent. were cured and 83 per cent. cured or improved. while with the common carotid only 46 per cent. were cured and 64 per cent. cured or improved. Locke's statistics of cases from 1907 to 1924 are almost the same. Admitting that fewer cases of internal carotid ligation were recorded, still the difference in results is striking.

The studies of Holman,[8] both clinical and experimen al, indicate that the best treatment for arterio-venous communication, in an extremity, is ligation of the artery and vein both proximal and distal to the lesion, followed by its excision. This complete procedure is impossible in the cranium but it is logical to suppose that the nearest approach to it would give the best results. The diagrams show the ideal plan of treatment in the simple anatomy of a limb compared with the complex anatomy of a lesion in the cavernous sinus. The nearest approach to the ideal in the latter condition might be, theoretically, as follows:

Proximally.—Ligation of the internal carotid artery and of the internal jugular vein.

Distally.—Ligation of the superior ophthalmic vein and of the ophthalmic artery.

In patients with distended orbital veins, ligation of the superior ophthalmic vein is generally conceded to be a very helpful procedure. If not distended. orbital vein ligation is probably not helpful. The ophthalmic artery is probably too inconsequential as compared to the circle of Willis to make its ligation worth while.

One may logically conclude, therefore, that the vessels to be occluded in a case of arterio-venous communication in the cavernous sinus are the internal carotid artery, and the internal jugular vein; and besides these, at a later stage, in a case with distended orbital veins, the superior ophthalmic vein (usually the superior, occasionally the inferior) should also be ligated. But in a case of simple aneurism of the internal carotid without venous communication, the internal jugular vein need not be ligated, though it would probably do no harm.

B. The method of arterial occlusion.

The easiest and most convenient method of immediate, complete ligation with chromicized catgut has certain disadvantages.

It is not suitable for permanent partial occlusion because after absorption, the artery may resume its full function. This may occur even with complete occlusion by simple ligature, unless the artery be divided. If chromic catgut is used, it is probably best to divide the artery, leaving two ligatures on its cardiac stump. But this implies immediate, complete, irrevocable occlusion,

leaving no means of escape should the signs of cerebral damage appear. This last objection applies to silk and to linen ligatures.

Halsted [9] and his co-workers, in 1905, and through succeeding years, published a good deal of work on the study of arterial occlusion. He became especially interested in the use of rolled aluminum bands. Matas and Allen,[10] in 1911, reported experimental and clinical data relating to the occlusion of large arteries with aluminum bands.

Their basic thought was the danger of immediate, complete, permanent occlusion. They sought means of testing the collateral circulation before final occlusion and also means of releasing the artery when danger threatened.

To be specific, Halsted rolled a band of thin aluminum sheeting two and one-half times round the artery. His idea was thus to produce partial occlusion. Then one of two things ensued. If the signs appeared of failing circulation to the part, the wound was reopened and the band released. If, however, after a few days or more, the circulation appeared adequate, the band was left *in situ* with the hope of gradual complete occlusion by fibrosis; or the wound was reopened to roll the band tighter for complete occlusion.

Matas and Allen [10] advocated a simpler technic in the use of a heavier aluminum band applied like the letter U about the artery. The degree of occlusion desired is controlled by compression of the U. If trouble appears, the wound is reopened and the band widened or, if all is well, the band, at a second operation, may be completely compressed. The metal is stiff enough to remain fixed yet easily manipulated.

Matas and Allen discovered that complete occlusion by their band could continue for seventy-two hours without damage to the intima and without thrombosis. Therefore, three days may elapse for the appearance of trouble with time still to release the artery intact without fear of embolism.

In 1911, Neff [11] reported his special aluminum clamp for gradual occlusion of an artery by a single operative procedure. Two blades are hinged to make a V. The artery rests between the blades which are approximated by rubber bands. The free ends of the blades are held apart by plain catgut wound around and between them. As the catgut absorbs, the blades approximate and compress the artery. Neff, Jennings and others have reported its use with success. In one case, the clamp annoyed the patient on swallowing and later was removed.

Kerr [12] and others report favorably on the use of fascia lata which we used in our patient, on the right side. Kerr practised a two-stage operation, first partial, and later complete occlusion. The main advantage of the fascia lata is that it can be depended upon for continued partial occlusion. It is not absorbed. At a second stage, if desired, completion of the occlusion with chromic will be effective.

Hitzrot [6] stated in 1927 in Wheeler's article, after a trial of chromicized pig's bladder (Baer's Membrane) in six operations to occlude the common carotid artery, that he believed that, in most cases, partial occlusion with

this material became complete in a very short time. This took place in our patient on the side on which Baer's Membrane was used.

In selecting the method of occlusion, we have then, four methods to choose from and several materials available for their fulfilment. They all presuppose pre-operative digital compression.

1. Gradual complete, permanent, arterial occlusion by one operation. This is the best method of all and for its accomplishment the Neff clamp, in the present state of knowledge, offers the best technic available. It may be that an exact adjustment of Baer's Membrane can be worked out to achieve this by a simpler procedure than that of the Neff clamp.

2. Partial occlusion followed, in due time, by a second operation, if needed, to complete the occlusion. This is the next safest method, but will usually require two operations. Here the U-shaped metal band of Matas and Allen appears to stand first. It is easily prepared, easily applied, easily adjusted, and, later, easily compressed to complete the occlusion. Further it is safe, accurate, secure and well-borne by the tissues. The rolled band of Halsted meets the same needs but is more difficult to prepare and to apply. Baer's Membrane and fascia lata are both available for this procedure, chromic catgut being used for the second stage operation. Linen or silk ligature or tape may be successful, followed later by chromic but a circular tie against the arterial pressure may be difficult of fine adjustment for partial occlusion.

In this connection, it should be emphasized that even partial occlusion may need release, and that the Matas-Allen band is of all the occluding agents, the most quickly and accurately released.

3. Complete occlusion which can be released if cerebral damage threatens. This is a bolder procedure and when used, the surgeon assumes that the chance of damage is very slight; but he must be prepared for immediate re-operation and release on short notice. Here the Matas-Allen band again holds first place. It is easily applied, as already emphasized. Its release is most simple, direct and immediate, by means of a knife-blade separating the ends of the U. Matas and Allen found in their excellent studies on the dog and after some clinical evidence, that the intima of the artery is intact for seventy-two hours after the careful application of their band in complete occlusion. This means that if evidence of cerebral damage appears during the first three days after complete occlusion by this method, the artery may be re-opened to function without fear of embolism from a thrombus. No other technic is so susceptible of accurate application and of accurate, quick release.

A few cases have been reported in whom cerebral damage appeared later than the seventy-two hour period. This possibility though remote, casts an imperfection upon the method of complete occlusion with possible subsequent release, because after seventy-two hours, the artery may be beyond recovery and an embolism may occur, if released.

4. Immediate, complete, irrevocable occlusion. This is the least desirable method of all. Any of the materials may be used for its accomplishment.

This was the method employed on the right side in our patient. This method has been the one most commonly used in this disease and many successful results have ensued; but if we are to reduce the mortality and the morbidity, one of the other measures is bound to give better results. These cannot be expected, however, without more care and preparation than is needed for the application of a simple tight ligature. Stimulated by the problems of the case herein reported, one of us (Hanford) practised several dog experiments in arterial occlusion. We used the Neff clamp, the Halsted rolled band and the Matas-Allen U-shaped band. Impressions gained from these few experiments may be stated as follows: The Neff clamp meets the indications better than any other material but its preparation and application require a technic not to be undertaken without considerable study and practice. At least one animal experiment should be made before its application to the human subject.
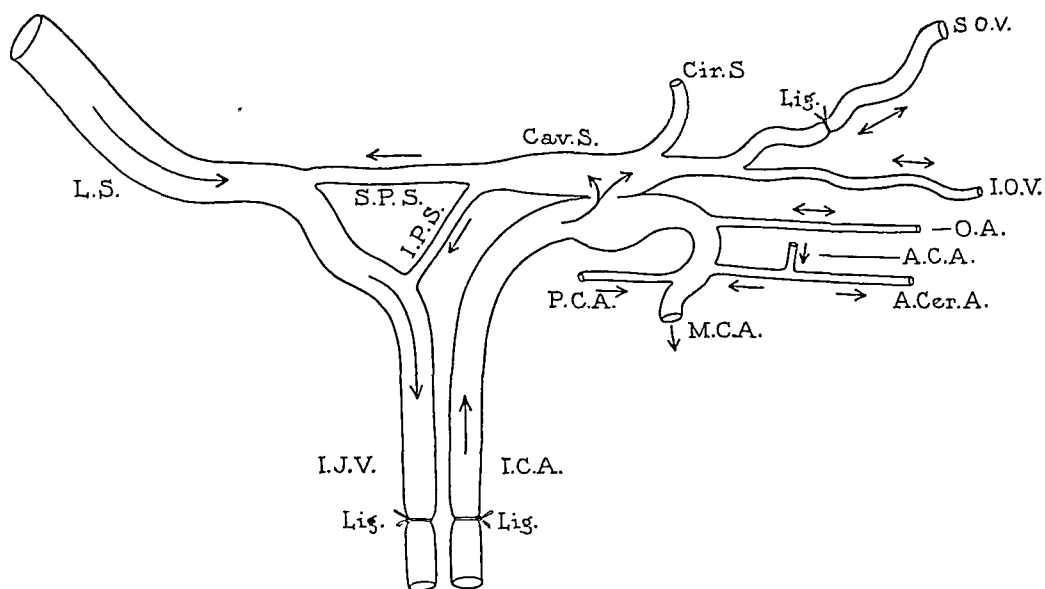
FIG. 6.—Diagram representing arterio-venous aneurysm between the internal carotid artery and the cavernous sinus with occlusion of the internal carotid artery and of the internal jugular vein in the neck and of the dilated superior ophthalmic vein in the orbit. An approach to the quadruple ligation. L.S.—Lateral sinus. S.P.S.—Superior petrosal sinus. I.P.S.—Inferior petrosal sinus. Cav. S.—Cavernous sinus. Cir. S.—Circular sinus. S.O.V.—Superior ophthalmic vein. I.O.V.—Inferior ophthalmic vein. I.J.V.—Internal jugular vein. I.C.A.—Internal carotid artery. O.A.—Ophthalmic artery. A.Cer.A.—Anterior cerebral artery. A.C.A.—Anterior communicating artery. P.C.A.—Posterior communicating artery. M.C.A.—Middle cerebral artery.

The Halsted rolled band of thinner aluminum (about No. 32 Brown and Sharp sheet metal gauge) must be accurately rolled around the artery which is not easily accomplished without practice before one attempts its use on a human artery. Besides this, it is not so very easily released by unwinding. The Matas-Allen U-shaped aluminum band (of No. 20 gauge) is easily prepared, easily applied either for partial or complete occlusion, quickly and accurately released or tightened at a second stage; and indeed is so simple in principle and practice as to require no other preparation on the part of the surgeon than to read Matas and Allen's article and to procure a small sheet of aluminum. It is more easily applied than fascia lata or Baer's Membrane, and also more easily released than these.

CONCLUSIONS

A case of pulsating exophthalmos is reported, a traumatic case without evidence of arteriosclerosis; caused probably by arterio-venous aneurism between the internal carotid artery and the cavernous sinus. The orbital veins were not appreciably engorged. An apparent cure has resulted after bilateral common carotid artery occlusion and after enucleation of the affected eye for persistent acute glaucoma.

The treatment for such cases may be outlined as follows:

1. Complete rest in bed, maintaining nutrition and using sedatives as needed.

2. If exophthalmos exposes the cornea or threatens evisceration, the lids should be approximated by suture through a special technic of eye surgery.

3. A period of digital compression of the common carotid artery with constant watch for signs of cerebral damage. It should be continued long enough to give it a fair trial as a means of cure by itself, and long enough to insure the safety of partial arterial occlusion by operation.

4. Operation, with regional block and local anæsthesia, through an obliquely transverse incision, to apply to the internal carotid artery of the affected side a Matas-Allen metal band for partial occlusion. At the same time the internal jugular vein is ligated. The patient is carefully watched for evidence of brain damage.

5. The indications for the orbital operation consisting usually of ligation of the superior ophthalmic vein have been stated by Sattler [3] and others to be:

(*a*) Distention of the orbital veins.

(*b*) When compression of the orbital veins obliterates the bruit.

(*c*) When carotid occlusion is contraindicated and its compression has failed.

(*d*) When carotid occlusion is followed by failure or recurrence, and the orbital veins are distended or their compression obliterates the bruit.

(*e*) It is best done after complete carotid occlusion of the affected side, before operation upon the opposite carotid.

Sattler also gives the following contraindications to the orbital operation. It is not to be done when the orbital signs are slight or no varicosities appear. Early cases are not suitable for it. It is better to wait until venous distension is well established.

6. If the partial arterial occlusion, after one or two weeks, has not been successful, the wound is reopened and the band compressed to complete the occlusion.

7. If complete occlusion of the artery on the affected side is inadequate and if the orbital operation has failed, then the opposite internal carotid artery should be treated like the first. It is first compressed and later partly occluded by the Matas-Allen band with the reservation that complete occlusion may be needed later. The vein this time is not ligated.

In young subjects without arteriosclerosis, in whom the collateral circula-

tion presumably is good, one may be tempted to proceed with immediate complete occlusion and thereby probably save the patient the two-stage operation.

If this be done, the Matas-Allen band takes first place among the materials available, on account of the facility of its release with renewed arterial function, if released within seventy-two hours of its application.

To the surgeon, who has become practised and confident in its use, the Neff clamp stands first. A valuable step in advance would be made, however, if some simpler device were evolved to accomplish this most desirable end of gradual complete occlusion by one operation.

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RESULTS OF TREATMENT BY AUTOGENOUS GLAND FILTRATE IN HODGKIN'S DISEASE

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Up to the present time, no conclusive evidence has been brought forward which would definitely indicate the nature of Hodgkin's disease. MacCallum[1] states: "The disease has some of the characters of a tumor growth, but by far the greater weight of evidence is in favor of its being an infectious process involving simultaneously much of the lymphatic system." Possibly much of the uncertainty which is still attached to this condition may be attributed to its laborious and slow crystallization as an entity, distinct from true leukæmia, pseudoleukæmia and lymph gland neoplasms. The sharp differentiation on a histo-pathologic basis is to be credited to Sternberg,[2] Reed[3] and Longcope.[4] In discussing the evidence which might have a bearing on the unsettled question of etiology, Clark[5] pointed out that Hodgkin's disease resembles an infectious process in the following ways: 1, there is an acute and a chronic form of the disease and the acute cases may run a peculiarly rapid and malignant course; 2, the disease may remain as a local affection for years and then become generalized and rapidly fatal; 3, the lymph glands most frequently affected are those which are most easily infected through the skin and mucous membranes; 4, it is specific for one particular tissue, namely, the lymphadenoid tissue; 5, its mode of spread is usually from the affected gland to the nearest; 6, it is often accompanied by a recurrent type of fever; 7, in the final stages there is cachexia and often diarrhœa, hæmorrhages from mucous membranes and pyrexia, as in the final stages of a septicæmia; 8, finally the disease has the histologic appearance of an infectious process. To these points may also be added as further suggestive evidence, the fact that the blood picture is usually more characteristic of an infectious process than of a neoplasm. That this is an infectious disease, as was pointed out by Ebstein,[6] has been generally although not universally accepted. Gibbons[7] contends that all of the points enumerated by Clark are not universally true of all cases, or might as easily be applied to certain types of tumors. Among those who believe that Hodgkin's disease is neoplastic in character are Coley, Oliver, Tsunoda, Mallory and Warthin.[8] Lubarsch and Levin believed it to be a border-line condition between inflammatory processes and malignant tumors, not degenerative but proliferative and therefore biologically identical with carcinoma cells.[8] Barron[9] believes that the inexorable progressive course toward a fatal termination is the only factor in which it is at variance with an infectious disease and harmonizes with malignant tumors. Symmers[10] has suggested another conception of Hodgkin's disease. He does not believe that this condition provides any criteria by which it may be grouped either among the inflam-

matory diseases or among the neoplasms. Its histogenesis, he suggests, is determined by 1, preliminary hyperplasia of the lymphoid cells in various parts of the body; and 2, by the discharge of mononuclear and multinuclear giant cells from the bone marrow with or without eosinophiles and eosinophilic myelocytes and their arrest by the hyperplastic lymphoid depots in pursuit of their function as filters, the fibroblastic reaction in the recipient tissues representing a mechanical process designed to support the excess of cells by which they are burdened.

Were the belief that Hodgkin's disease is of infectious origin supported by the constant and controlled finding of an organism which fulfilled Koch's postulates, the problem would be clearer. But this is not the case. Sternberg's[2] opinion that it is closely related to tuberculosis has not been universally accepted, although the recent publications of L'Esperance[11] stimulate interest in a possible relation to avian tuberculosis. This interest is heightened by Lay Martin's results with the use of avian tuberculin, as yet not published.[12] Dorothy Reed[3] had used tuberculin, with negative results in five cases.

Considerable interest was aroused by the publications of Fraenkel and Much,[13] Bunting and Yates,[14, 15] and Billings and Rosenow[16] dealing with a diphtheroid bacillus, the so-called *B. Hodgkini*. This organism they had recovered in many instances from the lymph glands in Hodgkin's disease. Furthermore its introduction into laboratory animals was sometimes followed by a generalized lymphadenoid involvement, not, however, typical of Hodgkin's disease. Autogenous vaccines, prepared from this organism, were used by these investigators and by others, including Fox,[17] Mellon,[18] and Bloomfield.[19] Its use, both with and without attendant röntgenotherapy was not successful in permanently curing the disease. Bloomfield found no special relation between this diphtheroid bacillus and Hodgkin's disease and isolated identical organisms from the lymph nodes from a great variety of sources both normal and pathologic. Negative results followed the attempts of Longcope,[20] Cunningham and McAlpin,[21] and Stewart and Dobson[22] to transmit Hodgkin's disease experimentally to anthropoid apes and other monkeys.

Coley,[23] who believes that Hodgkin's disease and lymphosarcoma are closely allied etiologically, states: "The tumors are as a rule extremely radiosensitive and are likewise responsive in a remarkable way to treatment with the mixed toxins of erysipelas and *bacillus prodigiosus*. Cases of lymphosarcoma so treated should show a cure or at least a complete control of the disease for a long period (five years or more) in a very considerable number of cases, *i.e.*, 10 to 15 per cent. Typical cases of Hodgkin's disease still show a very bad prognosis, and permanent control can be expected in only a very small number of cases."

In September, 1928, Wallhauser and Whitehead[24] published a preliminary report of their results with a new immunological method of treating

Hodgkin's disease. They made no assumptions regarding the specific nature of Hodgkin's disease, but confined themselves to the statement:

The use of autogenous extracts as carried out in our cases is based upon the premise that the disease is of toxic origin, and that the organisms described by Bunting and Yates, Billings and Rosenow and others, contribute secondarily to the disease picture. It is not our purpose to contend that the reactions observed in this series are of a specific nature. It is our belief that the specific lesions of Hodgkin's disease contain certain amounts of a toxin which when injected in small doses into unaffected tissues, stimulates the production of anti-bodies; and that it is the resulting removal of the etiological factor which arrests the pathological process and permits a return to normal. We are not prepared to make an issue of this point however, and wish to rest with a description of the procedure and the results obtained.

They summarize their method as follows:

The procedure consists essentially in the use of autogenous, bacteria-free extracts made from the specific lesions of the disease. This extract was given in small and usually increasing doses, subcutaneously. The treatment period extended over several months in each case. No other treatment was given excepting general hygienic direction, as noted in the case histories.

The summary of this preliminary report included the following:

The first effect noted was softening and regression of the enlarged nodes. This progressed steadily, leaving only fibrous nodules, which were hardly palpable and which also disappeared after several months. The cachexia was gradually but definitely reduced, finally disappearing entirely. Symptoms such as nausea, vomiting, urinary retention, anorexia and asthenia were relieved. The temperature reached the normal more slowly. Gain in weight was striking in two cases.

On May 21, 1929, Doctor Wallhauser was so kind as to inform me of the subsequent course of his original three and subsequent cases. At that date, of eleven treated cases, five he found improved, five had died (all causes) and in one the treatment had been discontinued.

It is for the purpose of adding further information to the subject that I am at this time publishing the results in nine cases treated by this method, although only one year has elapsed since beginning treatment. This short time, of course, allows one to entertain little more than an impression.

In all cases, the lymph glands which were used for the filtrate were removed under local anæsthesia. In none did any infection develop nor did the glands or filtrate yield any growth on culture. The filtrate used was prepared for me by Miss Mary Poston, through the courtesy of Doctor Harold Amoss, the Director of the Biological Division of the Medical Clinic of the Johns Hopkins Hospital.

The technic of preparation of the filtrate differed in some respects from that described by Wallhauser and Whitehead. The glands were cleaned of fat and washed of blood aseptically, in a "bacteria-free" room, with sterile normal salt solution. They were then placed in a "tissue press" [25] and the fluid of the glands collected. This was then filtered (Seitz) and the filtrate diluted with normal salt solution in amounts so that 1 gram of gland substance was represented in 5 cubic centimetres of filtrate plus normal salt

solution. This was incubated and cultured and if sterile was preserved by the addition of either 1 part sterile neutral glycerine to 2 parts filtrate, or 0.35 per cent. tricresol. The tricresol was found more satisfactory. This was then kept in rubber-stoppered bottles, and removed as used by means of a hypodermic needle. The filtrate was then administered subcutaneously, three times a week, beginning with 0.1 cubic centimetre and increasing 0.1 cubic centimetre per dose up to 0.5 cubic centimetre, or in some to 0.7 cubic centimetre per dose. The treatment was in general carried on as described by Wallhauser and Whitehead, that is, continued for six weeks, and following a two weeks' rest period was resumed for another six weeks. After a second rest period the treatments were given once a week until stopped.

REPORT OF CASES

CASE I.—L. C. M., white, age thirty-five years, was referred by Dr. T. B. Gunter, of West Palm Beach, Florida, to Dr. L. F. Barker, July 27, 1928. Axillary glands had been enlarged for about one and one-half years. There had also been loss of appetite and weakness. Itching of the skin and some shortness of breath had been noticed only recently. He has lost fourteen pounds in past few years. On physical examination the lymph glands are generally enlarged and of variable size, ranging from four to five centimetres down. The spleen is definitely felt four centimetres below the costal margin on deep inspiration. There is evidence of considerable scratching of the skin. Röntgenoscopic examination of the chest showed a definite increase in the width of the ascending aorta which encroached somewhat on the retrocardiac space as seen in the oblique view. The teleröntgenogram measurements were mediastinal right, 4.2 centimetres and mediastinal left, 8.7 centimetres. The blood examination showed red blood cells, 4,272,000; hæmoglobin, 60 per cent.; white blood cells, 10,400; polymorphonuclear neutriphiles, 85.6; polymorphonuclear eosinophiles, 1:6; polymorphonuclear basophiles, 0; small mononuclears, 6 per cent., and large mononuclears and transitionals, 6.8 per cent. The gastric analysis, stool and urine examination were negative. While under observation there was fever of 100 to 101 degrees each day. The microscopic examination of an excised lymph gland showed the changes typical of Hodgkin's disease, as described by Reed and Longcope. Culture of the gland was sterile.

Prior to the filtrate treatment this patient was transfused twice and had been irradiated (radium) by Dr. C. F. Burnam. There had been little change in his condition other than a drop in the white blood cells count to about 4,000. There had also developed a nearly complete ptosis of the right upper eyelid and a right-sided vocal cord paralysis. This was believed due to radium. At the time the filtrate was started there was daily fever of 101 degrees. October 26, 1928, the first dose of filtrate was given and increased every other day, as outlined above, up to 0.5 cubic centimetre. November 12 the temperature had come down to normal and remained normal during the rest of the time this patient remained in the nursing home. November 17 the ptosis had entirely cleared, although the vocal cord paralysis remained and did not change while under observation. The glands became definitely small, according to three observers, although not particularly softer. The spleen was not palpable at the time the treatment was started. No further radium was used after filtrate was started. October 30, 1928, the red blood corpuscles numbered 3,856,000, hæmoglobin, 63-65 per cent., and white blood corpuscles 5,600. The patient claimed to feel better and stronger, although there was no increase in weight. November 26 after one month of treatment the red blood corpuscles were 3,744,000, hæmoglobin, 60 per cent., and white blood corpuscles 6,300. The patient then returned to his home in Florida, and was to continue the treatment as outlined above. About December 1 the fever returned, 99.2 to 102 degrees, and patient went back to bed. Early in January his condition was much

improved, the fever had subsided and glands were smaller and softer. He had gained in weight. January 16, red blood corpuscles 4,310,000 hæmoglobin 66 per cent.; white blood corpuscles 7,850. The filtrate had been given from October 26 until December 15 and was stopped until about January 1. Coincident with resuming treatment this patient became progressively worse and died March 27, 1929.

CASE II.—P. B. S., a white man, age forty-eight years, consulted Dr. S. R. Miller, of Baltimore, November 25, 1928, because of failing endurance. The history of this patient is interesting because this was his only complaint, for which he had had several teeth extracted during the previous summer. He had felt overworked, had lost ten or twelve pounds in weight, had been sleeping poorly and was annoyed by a slight cough. On physical examination no general glandular enlargement was found; although there were two enlarged lymph glands below the outer border of the lower end of the left sterno-mastoid muscle, and the right inguinal glands and left axillary glands were enlarged. There was modified impairment of the percussion note on both sides close to the sternum at the level of the second costosternal junction. In the back the percussion note was impaired in the interscapular region from the third to the seventh vertebral spines, somewhat more marked on the right than on the left side. There was irregular fever of 100 to 101 degrees. Stereoröntgenoscopic examination of the chest showed an increased mediastinal shadow.

November 28, 1929, one of the lymph glands in the left lower cervical region was removed and was believed by Dr. W. G. MacCallum to show the changes characteristic of Hodgkin's disease.

Between November 27 and December 12, 1928, the red blood corpuscles count averaged 3,800,000 and the white blood corpuscles count 13,000. Filtrate treatment was started December 12, and at the same time the patient was kept in bed with forced nourishment, administration of liver extract and Blaud's pills. After ten days the red blood cells count had increased to 4,500,000, the white blood corpuscles count to 18,000. The filtrate dosage was kept at 0.5 cubic centimetre December 23, immediately after returning home from the hospital, the patient had severe attacks of abdominal pains accompanied by diarrhœa and occasional nausea. The filtrate was discontinued and resumed after return to hospital early in January, 1929. There was no perceptible progress. In spite of forced feeding it was impossible to increase the patient's weight. Liver extract and Blaud's pills were not tolerated well and the filtrate was the only treatment given during January and February, when it too was discontinued by the patient. He felt well in March, then had a relapse in April, was able to follow a golf match in May but has since retrogressed steadily. No treatment is being given, partly owing to an unwillingness on his part to acknowledge the seriousness of his condition.

CASE III.—C. R., white, age thirty-six years, had been treated by Dr. C. F. Burnam since March, 1926, with radium and deep X-ray. The diagnosis of Hodgkin's disease had been made in February of that year by Doctor Mills of Colorado Springs. His enlarged glands were confined almost entirely to the cervical and axillary regions and had been very amenable to irradiation until January, 1929, when, following influenza and broncho-pneumonia, there was recurrence of the glandular enlargement, lassitude and persistent cough. March 6, 1929, there remained a large, hard mass of fused glands above and behind the right clavicle. The skin over the right cervical and axillary glands was tanned a deep mahogany brown. March 7, 1929, a röntgenoscopic examination of the chest showed the heart and aorta within normal limits and a small area of unresolved pneumonia (rather than pleurisy) at the right base. (Dr. F. H. Baetjer.) The blood examination showed: red blood corpuscles, 3,870,000; hæmoglobin, 66 per cent.; white blood cells, 8,800; polymorphonuclear neutriphiles, 81 per cent.; polymorphonuclear eosinophiles, 1 per cent.; small lymphocytes, 14 per cent.; large mononuclears and transitionals, 4 per cent.

The temperature rose to about 100 degrees every day. March 8, 1929, the glands of the left axilla were removed for preparation of the filtrate. March 10, 1929, a skin

sensitization test was done with the filtrate of another individual with Hodgkin's disease. A small wheal and some increase in fever resulted. March 11, 1929, treatment with the patient's own filtrate was started and by March 22, the patient was getting 0.6 cubic centimetre every other day. March 22 he was discharged from the hospital and the glands of the right side of the neck were noted as being much smaller. From March 22 until May 1, 0.5 cubic centimetre of the filtrate was given every other day. At about this time the patient began to notice each morning a definite swelling of his face and neck. His cough had become increasingly annoying. On May 15 was found a flat, rounded swelling about 10 centimetres in diameter, fluctuant, over the lower right chest—covering the area of the 10th, 11th and 12th ribs. The percussion note over the whole right chest was flat. Thick creamy pus, sterile on culture, was aspirated from the fluctuant area, and 2500 cubic centimetres of clear amber fluid were removed from the right chest. A röntgenogram after thoracentesis showed erosions of the 11th and 12th ribs. A week later thoracentesis was repeated, 2000 cubic centimetres being removed. Although the supraclavicular glands had diminished in size during the period in which the filtrate had been used, the development of pleural exudate, bone erosions and the sterile abscess in the back prompted us to return to the use of the agent which had kept this patient in good condition for three years, namely, irradiation.

From this period on, this case loses interest as far as the use of the filtrate is concerned. We have at intervals given him further irradiation; there have been several additional thoracenteses, at monthly intervals, and we continued the administration of 0.6 cubic centimetre of filtrate once weekly, until September 15, 1929. The patient is a farmer and works eight hours daily.

Case IV.—M. R., a colored woman of twenty-eight years, had noticed her enlarged glands in December, 1928. When seen in the University Hospital on March 7, 1929, she complained of weakness, restlessness and shortness of breath. She had lost twenty-five pounds during the preceding year, was obviously anæmic, and the general glandular enlargement was striking. Some of the glands were the size of a lemon. The skin showed evidences of scratching, with irregular leukoderma and melanoderma. The mediastinal dulness was slightly increased on both sides. The spleen was enlarged about 5 centimetres below the costal margin, and on deep palpation there was a suggestion of retroperitoneal glands. There was slight œdema of the feet and ankles. Röntgenogram of the chest on December 7, 1928, showed broadening of the upper mediastinal shadow, with sharply outlined borders. There was moderate increase in root shadows with enlargement of the glands of the left hilus. The temperature was the typical Pel-Ebstein type, reaching about 102 degrees. There was no free gastric hydrochloric acid. There was sugar in the urine. The red blood cells count was 1,110,000; hæmoglobin, 35-40 per cent.; white blood cell counts 30-32,000; polymorphonuclears, 90 per cent.; eosinophiles, 0; transitionals, 8 per cent., and myelocytes, 1 per cent.

The microscopic examination of an enlarged gland showed the typical changes of Hodgkin's disease, rather far advanced.

The filtrate treatment was started March 9, 1929, and by March 17, the patient was receiving 0.5 cubic centimetre every other day. On the 17th, during which time the patient had been in bed, definite diminution in the size of the glands was noted. The spleen was smaller by measurement. This was again noted March 25. The glands were also softer. The only other treatments used were Blaud's pills, 60 grains per day, and dilute HCl. By April 15, the feeling of improvement was less. The fever was reaching 104 degrees, although the glands and spleen were definitely smaller and softer. During the period of administration (while remaining in bed in the hospital) the blood picture had improved. March 25, the red blood cells were 2,150,000; the hæmoglobin, 45 per cent.; white blood cells, 3,200. April 1 the patient insisted on discharge from the hospital and returned three times a week for 0.5 cubic centimetre of filtrate. She died suddenly at home April 13.

Case V.—E. E. L., a white man, age thirty-six years, was referred to Dr. L F.

Barker by Dr. Harold Disbrow, of Lakewood, N. J., February 8, 1929. He had had meningitis when a child, which had affected his hearing. During the two years before consultation he had become nervous and tired easily. Enlarged glands in the right axilla and groin had appeared during the past year and on consulting Doctor Disbrow in January, 1929, the general glandular enlargement was found. A gland was removed at this time and examined by Doctor Mallory, of Boston, who did not feel that an accurate diagnosis could be made. Skin itching had not been noted. There had been one febrile ˉattack (possibly influenza) recently, but otherwise the temperature was said to be normal. It might be noted that this patient has a farm and is in close contact with poultry.

Other than a general glandular enlargement and palpable spleen, the physical examination was essentially negative. Some of the lymph glands were as large as walnuts.

In a röntgenoscopic examination of the chest, the lungs appeared slightly hazy, particularly on the right where there was increased fibrosis about the hilus.

A lymph gland was examined microscopically and its appearance did not permit a definite diagnosis. There was slight peripheral scarring and the germinal centres were fairly well preserved. The tissue was predominantly lymphoid, with only a slight reticulo-endothelial increase, and only small numbers of eosinophiles. There were no definite Dorothy Reed cells, no giant cells nor any other evidence of a specific disease. Several members of the Department of Pathology in the Johns Hopkins Hospital thought that the gland represented early Hodgkin's disease. This section was commented on by Dr. J. B. Ewing, of New York, as follows: "Chronic granuloma of lymph node. Hodgkin's diagnosis based on clinical and pathological picture, although the latter is not absolutely definite."

The blood Wasserman was negative. The blood count on February 8, 1929, showed red blood cells, 4,914,000; hæmoglobin, 85 per cent; white blood cells, 7,300, of which the polymorphonuclears were 54.4 per cent.; eosinophiles, 5.2 per cent.; basophiles 1.2 per cent.; small mononuclears, 34 per cent., and large mononuclears, 5.2 per cent. The urine and stool examinations were negative.

The filtrate was administered by Doctor Disbrow, and on October 11, 1929, Dr. L. F. Craver, of the Memorial Hospital in New York, reported to me as follows: "In regard to the result in his case from the use of your filtrate, the patient stated to us that after a month's treatment he became run down, developed bronchitis and was in bed for two weeks, but that subsequently following a rest in the country, he showed marked improvement and gained eight pounds." In March 1930, Doctor Disbrow reported to me that the patient had died.

CASE VI.—L. H., a white boy, age nine years, in August, 1928, noticed enlarged cervical glands and had a daily fever of about 101 degrees. The blood count at the time was red blood cells, 4,280,000; hæmoglobin, 72 per cent. Differential: polymorphonuclears, 87 per cent.; small mononuclears, 9 per cent., and large mononuclears and transitionals, 4 per cent. Röntgenoscopic examination of the chest showed that the mediastinal glands were markedly enlarged with some root infiltration on the left side. A cervical lymph gland was excised and showed the typical changes of Hodgkin's disease. Treatment by irradiation was carried out through the succeeding months by Dr. C. F. Burnam. He did well and the blood examination during that time showed the following: Red blood cells, 4,000,000; hæmoglobin, 73 per cent.; white cells, 7,500; polymorphonuclears, 75 per cent.; eosinophiles, 3 per cent.; small mononuclears, 18 per cent.

Röntgenoscopic.—There was marked improvement in the appearance of the chest. There was still evidence of a mediastinal mass but it was disappearing on the left side where it was most marked. The weight was 83¼ pounds September 27, 1928. October 20, 1928, it was 93½ pounds.

November 19, 1928, the cervical glands were practically normal on palpation. There was slight impairment of the percussion note on the left side at the level of

Ludwig's angle about 6 centimetres from the mid-sternal line and about 2½ centimetres on the right. The spleen could not be felt. The weight was 103½ pounds. Röntgenoscopic examination of the chest on this date showed a definite improvement, in that the shadow noted prior to this did not extend so far up as it had in earlier examinations. The straight line which was seen in previous plates seemed to be irregular and the density of this shadow was not so marked.

January 26, 1929: Red blood cells, 4,500,000; hæmoglobin, 84 per cent.; white blood cells, 6,400; polymorphonuclears, 73 per cent.; polymorphoesinophiles, 0; small mononuclears, 22 per cent.; large mononuclears, 5 per cent. February 21, 1929: *Röntgenoscopic.*—The shadow is less dense than in the previous plates and does not extend as far into the neck.

About this time, the patient had a severe cold which was slow in subsiding. He developed a persistent cough and for the first time began to lose weight. The cervical glands began to enlarge. March 25, 1929: The mass seemed the same size if not a little larger and seemed to extend farther on the left side. It was somewhat denser. The trachea showed evidence of compression just above the level of the first rib and extending through the second and third ribs.

So much irradiation had been used that it was thought advisable to avoid further treatments if it were possible, and on March 28, 1929, Doctors Hamburger and Burnam referred this patient to me for filtrate treatment.

April 1, 1929: A few hours following the second injection, 0.2 cubic centimetre, the boy had an attack of rather acute respiratory difficulty. He could breathe with relatively less difficulty only in a sitting position, and had a troublesome cough. Treatment was discontinued. The mediastinal dulness measured 11 centimetres in the second interspace. The respiratory difficulty gradually subsided. April 16, 1929, filtrate treatments were resumed and the dosage was gradually increased to 0.7 cubic centimetre, at which point his fever was increased and respiratory difficulty reappeared. It was decided to discontinue treatments and resume irradiation. The boy gradually became better and began to gain in weight. He did well until June 15, 1929, when he was seized with very acute difficulty in breathing, and died after about three hours.

This case brings out several noteworthy features even though its use in evaluating the filtrate treatment is marred by the coincident use of irradiation. The lymph glands, although previously much irradiated, yielded a filtrate of apparent considerable effect. Unless it may have been coincidence, a dose of 0.2 cubic centimetre brought about a local effect in the tracheal glands which caused difficulty in breathing. When the dose was increased to 0.7 cubic centimetre there was a general as well as a local reaction. It may have been an error to increase the dose to an amount which would produce a general reaction but I believed it advisable to learn whether the filtrate from these previously much irradiated glands had any therapeutic value. On the other hand it may have been that we were dealing with an intractable acute exacerbation of the disease, with marked tracheal involvement and that the course of the disease was actually little affected by the filtrate. Unfortunately a necropsy was not done so that we have no information regarding the peritracheal glands which, in the röntgenogram, almost suggest actual invasion of the trachea. Invasive Hodgkin's glands have been observed not infrequently, sometimes so marked that a sarcomatous transformation has to be considered. These usually have occurred in the mediastinum and have been thought by many to have originated from the thymus. Ewing concluded that the invasive form of mediastinal Hodgkin's disease is in

reality a thymic tumor which should be separated from other forms of the disease, and which owes its malignancy to its origin from peculiar reticulum cells of the thymus. (Simonds.[8])

CASE VII.—R. L., white man, age forty-four years, was referred by Dr. C. H. Berlinghof, of Binghamton, N. Y. He had had enlarged right cervical glands for about one and one-half years. He had been gassed during the war, and had been troubled by a chronic cough since 1918. The sputum was negative for *B. tuberculosis*. During the past year he had lost five to ten pounds in weight and had had nocturia once or twice every night. The epitrochlear, inguinal, and cervical glands were definitely enlarged. The axillary glands were not so pronounced. The spleen was occasionally palpable.

The red blood cells count on December 28, 1928, was 4,120,000; hæmoglobin, 67 per cent. A lymph gland excised January 2, 1929, by Dr. William H. Hobbs, in Binghamton, showed the changes typical of Hodgkin's.

In June the patient was examined in Baltimore. The red blood cells count was 2,700,000; hæmoglobin, 43 per cent., and white blood cells, 2,700. The urine was red and turbid; positive for albumen; the guaiac was positive and the smear showed red blood cells and casts. Röntgenogram of the chest showed enlarged heart and aorta with marked root infiltration. The temperature ranged between 99.5 and 103.5 degrees.

A filtrate was made from glands excised June 15, 1929, and the patient returned to his home. The treatment has been given by Doctor Berlinghof.

August 28, 1928, Doctor Berlinghof reported that following the injections of 0.1 cubic centimetre on June 21, and 0.2 cubic centimetre on June 23, there was no reaction. The night of June 25, following 0.3 cubic centimetre, the temperature rose to 101 degrees accompanied by hot flashes and weakness. The next day the temperature was 102 degrees and remained about there until July 2. Until July 8, there was subnormal temperature. On July 9, 0.1 cubic centimetre was given, followed by a severe reaction with temperature of 101.8 degrees in twelve hours, tingling of extremities, throbbing in head, succeeded by drowsiness and great weakness. The urine has continuously shown blood and this man's condition was so bad that Doctor Berlinghof hesitated to stir him up even by the use of minimal doses of the filtrate. The lymph glands have diminished greatly in size. I suggested that the filtrate be diluted and smaller doses used. This was more satisfactory but more than 0.1 cubic centimetre of the undiluted filtrate could never be given without reactions. Death occurred October 1, 1929.

CASE VIII.—N. S., a white man age, thirty-five years, was referred by Dr. C. A. Meals, of Braddock, Pa., to Dr. T. P. Sprunt and Dr. J. A. C. Colston, of Baltimore, in July, 1929. He had had a left nephrotomy performed in 1914, tonsillectomy in 1919, and appendectomy in 1924. Of recent years he has had recurrent attacks of pain in the left renal region, typical of a renal colic he had had since boyhood. Dating from 1927, there had been a slow progressive enlargement of the cervical, axillary and epitrochlear lymph glands. In September, 1928, lymph glands were removed from the right axilla. During the spring of 1929, he had had a slight chronic cough, accompanied by increasing weakness and daily pyrexia.

On examination, he was moderately undernourished. There were enlarged cervical, axillary and epitrochlear glands. The inguinal glands were palpable. The spleen could be felt. There was deep abdominal tenderness on the left. The retromanubrial dulness was increased, particularly on the left. The temperature was irregular, rising to 101 degrees.

Cervical lymph glands were removed July 15, 1929, for diagnosis and preparation of filtrate. On section they presented the typical picture of Hodgkin's disease. Left nephrectomy was performed by Dr. J. A. C. Colston August 2, 1929. He was discharged from the hospital in good condition August 25, 1929, was sent home and the

filtrate was to be given by Doctor Meals. October 28, 1929, the patient reported that there had been no change in his general condition, that he was having continuous fever up to 101 degrees, and that many new lymph gland enlargements had appeared under the arms and all around the neck.

CASE IX.—H. S., white, age thirty-seven years, was referred by Dr. J. C. Bloodgood June 19, 1929. In a general physical examination in September, 1925, for symtoms referable to a cardiac condition, the peripheral lymph glands were not noticeable. For these symtoms he was in a hospital in September, 1927, where one enlarged left cervical gland was found enlarged and excised for diagnosis. It was thought to represent a chronic inflammatory reaction, or possibly "lymphoma." In January, 1928, the patient was examined in the Johns Hopkins Dispensary. He had several discrete, firm, rubbery, freely movable glands above the left clavicle. The heart condition was thought to be due to mitral and aorta insufficiency, mitral stenosis and myocardial decompensation. In May, 1929, another lymph gland was excised. Hodgin's disease was diagnosed (Doctor Bloodgood) and the patient referred for filtrate treatment. No demonstrable evidence of a mediastinal mass was found in X-ray.

At the time filtrate treatment was started, June 24, 1929, he was well nourished and able to work as a tailor. The lymph gland involvement was limited to the left supraclavicular region, where there was a mass of conglomerate glands elevating the skin, about the size of half an orange. There was one large gland in the left axilla and one beneath the angle of the jaw on the left.

About ten days following the initiation of filtrate treatment, one could be sure that the large mass above the clavicle was smaller and somewhat softer. The individual glands could be felt more distinctly and were a little more movable. Toward the end of July, about the fifth week, this regression had ceased and enlarged glands became palpable about the periphery of the original mass. The patient was having difficulty wearing a collar. At his urgent request, most of the larger mass of glands was excised, which I was very willing to do in order to examine microscopically glands from a patient after six weeks of treatment. This was done and the treatments, resumed August 15th, were continued until January, 1930. By that time it was apparent that the condition was progressing. Radium was used with marked benefit. The patient's general condition improved, and the supraclavicular glands diminished in size. We have continued using the filtrate with the hope that the combined treatments will be more effective than either agent alone.

SUMMARY OF CASES TREATED

CASE I.—In a previously irradiated patient, confined to a nursing home, a remission took place shortly after beginning treatment. This remission continued for two months, but death took place during the fifth month.

CASE II.—This patient presented very severe general effects (lassitude, fever, anæmia, leucocytosis) from a localized cervical and mediastinal glandular involvement. There was no indication that the disease was in any way affected by filtrate treatment extending over ten weeks. Treatment discontinued by the patient and his condition remains grave.

CASE III.—A patient with supraclavicular and axillary involvement controlled for three years by irradiation, who recently had developed bone lesions (ribs) and hydrothorax, was not noticeably affected by eight weeks' filtrate treatment. Treatment continued for four months at weekly intervals, combined with irradiation.

CASE IV.—The condition was very generalized and advanced. Immediately following initial filtrate treatments, the glandular and splenic tumors

became smaller and softer. The anæmia improved slightly but the high fever persisted. Death after four weeks of treatment.

CASE V.—A very early case of Hodgkin's disease was unimproved following four weeks of filtrate treatment. Improvement followed discontinuance of treatment and rest in bed. Weight also improved. Later recourse was had to irradiation, but death occurred in about one year.

CASE VI.—Cervical, peritracheal and mediastinal glands had been extensively irradiated prior to filtrate treatment. This patient was either very sensitive to the filtrate or it was administered just before the exacerbation which ended in death.

CASE VII.—This patient presented fairly advanced Hodgkin's disease complicated by nephritis. He was apparently as sensitive (temperature effects) to the filtrate as the patient of Case VI. Following very few treatments the glands decreased greatly in size, but death occurred four months after start of treatment.

CASE VIII.—Disease of about two years' duration, confined to cervical, axillary and epitrochlear glands, with slight splenic enlargement. Nephrectomy, for pyonephrosis, performed immediately prior to filtrate treatment. Filtrate treatments for six weeks have had no apparent effect on the course of the disease.

CASE IX.—Disease of four years' duration, localized to left cervical and axillary groups of glands. Definite improvement for very short time following initiation of treatment, but condition later was not perceptibly affected. Irradiation was instituted with marked benefit.

CONCLUSIONS

Nine patients who had Hodgkin's disease were treated by the immunological method suggested by Wallhauser and Whitehead. This treatment consists in the frequent administration of small doses of a diluted filtrate, the extract of affected lymph nodes.

Five died of the disease, three of whom had transitory remissions. One seemed unaffected by the treatment and returned to irradiation. One seemed very slightly improved for a time but retrogressed and was irradiated. One was apparently unaffected after ten weeks and another after six weeks.

These results are not clear enough to indicate whether or not the filtrate treatment has an appreciable effect on the usual course of Hodgkin's disease. Four cases suggest that it may be instrumental in bringing on a remission. Should the experience of others confirm this, it is to be hoped that this treatment will be given an extensive trial, preferably with no other treatment, but if conditions demand, combined with irradiation.

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HARE-LIP AND CLEFT PALATE*

AN ANALYSIS OF 184 CASES

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DURING the past ten years we have seen 184 congenital malformations of the lip and palate at Bellevue Hospital; 173 of these were in children and eleven in adults.

The various types of malformation were as follows:

Unilateral incomplete uncomplicated hare-lip	18
Unilateral incomplete hare-lip; cleft alveolus	3
Unilateral incomplete hare-lip; incomplete cleft palate	7
Unilateral incomplete hare-lip; complete cleft palate	4
Unilateral complete uncomplicated hare-lip	3
Unilateral complete hare-lip; cleft alveolus	4
Unilateral complete hare-lip; incomplete cleft palate	6
Unilateral complete hare-lip; complete cleft palate	44
Incomplete cleft palate uncomplicated	35
Complete cleft palate uncomplicated	2
Bilateral incomplete uncomplicated hare-lip	1
Bilateral incomplete hare-lip; incomplete cleft palate	1
Bilateral incomplete hare-lip; complete cleft palate	1
Bilateral complete uncomplicated hare-lip	2
Bilateral complete hare-lip; cleft alveolus	2
Bilateral complete hare-lip; complete cleft palate	26
Miscellaneous: Hare-lip—no description given	3
Cleft palate—no description given	3
Hare-lip and cleft palate	5
Bilateral hare-lip and cleft palate	1
Hare-lip previously repaired	2
Bilateral hare-lip, previously repaired	1
Repaired hare-lip with cleft palate	9
Cleft palate, previously repaired	1
	184

Forty-five of these patients were never operated upon, twenty-two dying and the majority of the others never being in a satisfactory physical condition to attempt surgical interference. In a few the cleft in the palate was so wide that operation was deferred and they failed to return.

Age of operation.—The lip and alveolus should be repaired as soon after birth as the infant's physical condition will permit, which is usually at the end of ten days or two weeks, if the birth weight has been regained and feed-

ing is satisfactory. At this early age the bones are more pliable, moulding of the alveolus is easy, the patient will be able to nurse normally and the horrible deformity which the parents abhor will be corrected. The cleft in the palate, if present, is usually too wide to attempt closure at this time, but correcting the deformity of the lip and the alveolus facilitates the normal growth of the bony palate and the width of the cleft diminishes as the infant develops. We formerly felt that the palate should be repaired as soon as the cleft was narrow enough to insure a moderate degree of success, which was usually between the first and the second year. After analyzing this group of cases and realizing the high mortality and comparatively poor results in many of these patients with cleft palates, we are strongly inclined to agree with
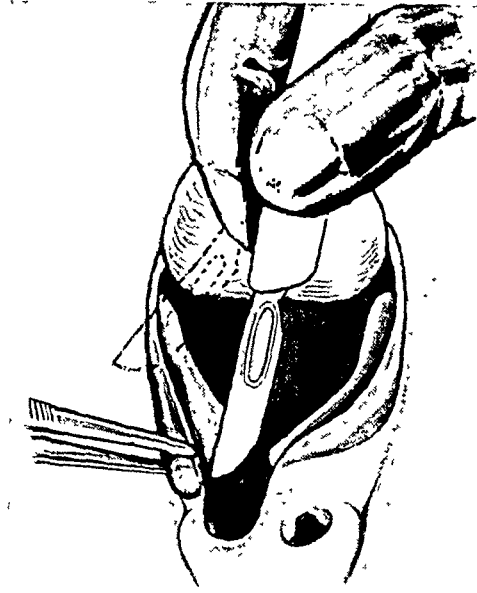
FIG. 1.—Incising the mucous membrane at its reflection on to the cheek and dividing the attachment of the ala nasi.
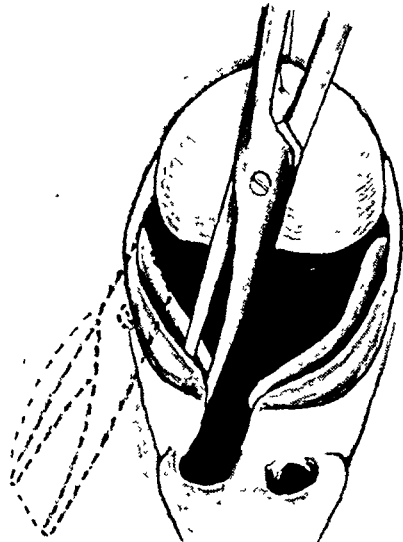
FIG. 2.—Freeing the soft tissues of the cheek by blunt dissection with further division of the ala nasi if necessary.

some of the earlier writers on this subject and postpone the operation on the palate until the child is at least three years old and preferably older.

While many advocate the repair of the palate before the child begins to talk in order that speech may not be affected, our feeling is that no matter how successful the operation is, speech will be far from normal and all these patients must be labored with by teachers and parents irrespective of what age the closure may have been obtained.

Operation.—In the operation on the lip or palate the patient should be in the Rose position and secured to the table, the surgeon sitting at the head and an assistant standing on either side facing the operator. The first sponges and assists in passing and tying the sutures, the second keeps the nasopharynx free of blood and mucus with the aspirator and depresses the tongue when necessary. Ether vapor is administered through a nasal tube or a crooked metal tube placed in the angle of the mouth, similar to that used in tonsillectomy. A preliminary suture is always passed through the tongue and is

not removed until the child is well out of the anæsthetic. We prefer the use of the Whitehead mouth gag in all palate cases.

HARE-LIP

Incomplete Hare-lip.—In which the tissue of the lip and nostril above the actual fissure are normal. In this type of case the simple operation of Nelaton or Graefe gives excellent results. A more common variety is that in which the tissues above the fissure are abnormal. The skin margins have coalesced but the deeper muscular portions have failed to unite and the nostril is wider than it should be. To obtain a satisfactory result in this type of deformity all the thinned tissue must be removed and the incomplete cleft converted
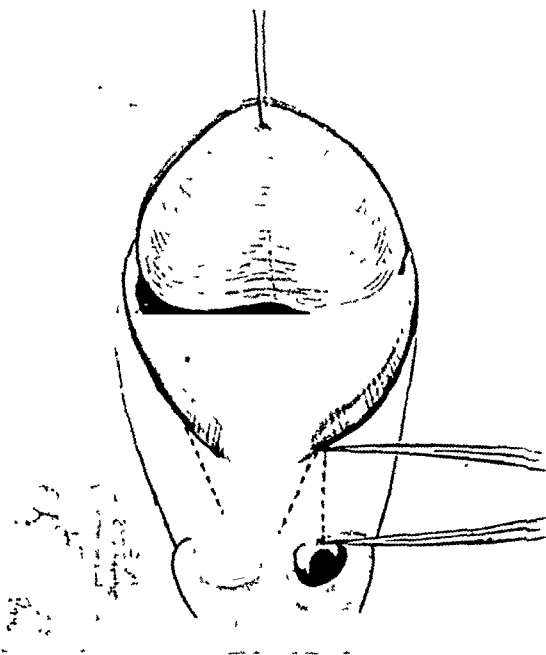
FIG. 3.—Estimating the width of the normal lip with dividers and outlining proposed incisions on the cleft side.
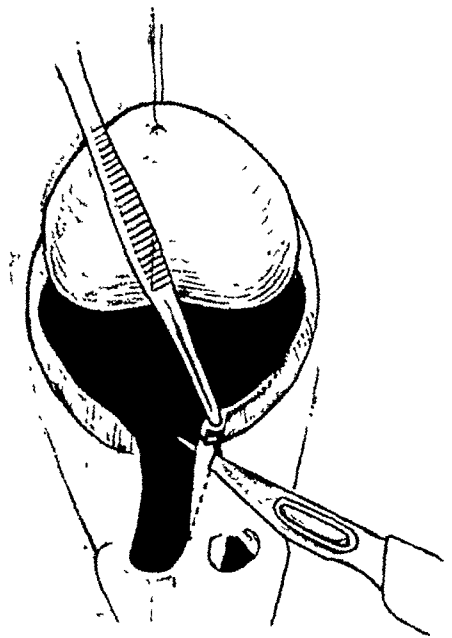
FIG. 4.—Transfixing of flap from below upwards.

into a complete one. Therefore the same operative procedures are applicable as in the complete cleft.

Complete Hare-lip.—A—With a normal alveolar arch. 1. To approximate the edges of the cleft without tension and to correct the flattening of the nostril it is essential to free the lip and ala nasi from their attachment to the maxilla. An incision is made through the mucous membrane at the site of its reflection on to the cheek, the attachment of the ala nasi is divided and by blunt dissection the soft tissues are freed nearly to the orbit. Bleeding is controlled by immediately packing the cavity with gauze which is removed before the sutures are inserted. (Figs. 1 and 2.)

2. The width of the normal lip is measured with dividers and the instrument transferred to the affected side. To estimate the width of the lip on the inner side of the cleft, one point of the dividers is placed at the inner margin of the nostril at a point where the new floor is to join the columella. the other at the vermilion border. On the outer side enough tissue must be saved from

the margin of the cleft to form the floor of the nostril. This means that the upper point of the proposed incision will lie considerably inferior to the corresponding point on the inner side. Due to the widening and flattening out of the vermilion border as the lip approaches the cleft, care must be taken to place the incisions far enough laterally to insure an adequate repair. (Fig. 3.)

3. The flaps are now transfixed with a sharp, pointed bistoury from below upward beginning at the vermilion border. The tabs of tissue still attached at the vermilion border are grasped at their tips with forceps and by making sufficient traction the hæmorrhage is easily controlled until the bleeding points have been seized. The edges of the cleft are now approximated, one or two interrupted sutures being inserted well within the nostril to bring the
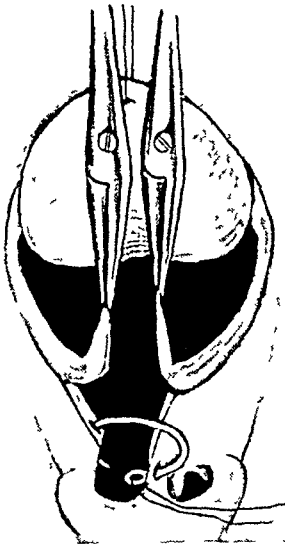
FIG. 5.—Flaps still attached at vermilion border grasped with forceps and first suture inserted within nostril bringing tissue from outer side of cleft around to form the floor of the nostril. (The needle should have been drawn coming out within the nostril)
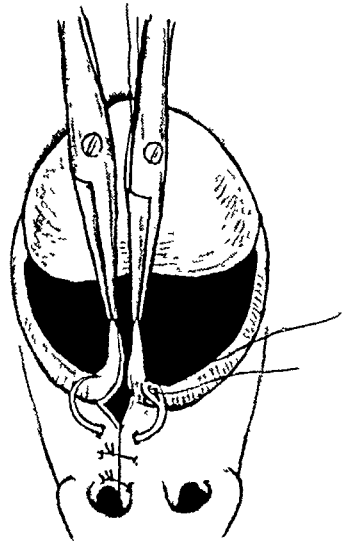
FIG 6.—Suturing of cleft.

tissue from the outer side of the cleft, which has not been pared, around to form the floor. The remainder of the cleft is now sutured with interrupted horse-hair or "dermal," each stitch passing through the entire thickness of the lip. If the margins of the cleft are thinner than normal they can be widened by making a vertical incision about one-eighth of an inch deep at the right angles to their cut surfaces. As the vermilion border is approached care must be taken to identify it, to thereby insure an accurate approximation. This is facilitated by sponging the tissues with peroxide of hydrogen to remove the blood and rapidly wiping it off with salt solution. The tabs of tissue from the margin of the cleft are now divided downward at an obtuse angle from the vermilion border leaving sufficient tissue to produce a slight pouting, thus allowing for subsequent contraction. (Figs. 4, 5, 6, 7 and 8.)

If the tissues of the outer margin of the cleft are thicker than those on the inner side a more satisfactory approximation may be obtained by dividing the inner margin of the cleft at an angle rather than approximating the edges vertically. There should be no tension of the suture line if the soft parts have been adequately separated from their attachment to the superior maxilla. However, if a flattening of the nostril persists, a double suture of silkworm gut may be passed through the floor of the nostrils, thus obtaining moderate pressure on each ala through the use of a small shirt button or piece of gauze. As our experience has broadened in this type of case we have been able to reconstruct more satisfactory nostrils and there has been less necessity for this retaining suture.

   B—With cleft of the alveolar arch. The majority of complete hare-lips
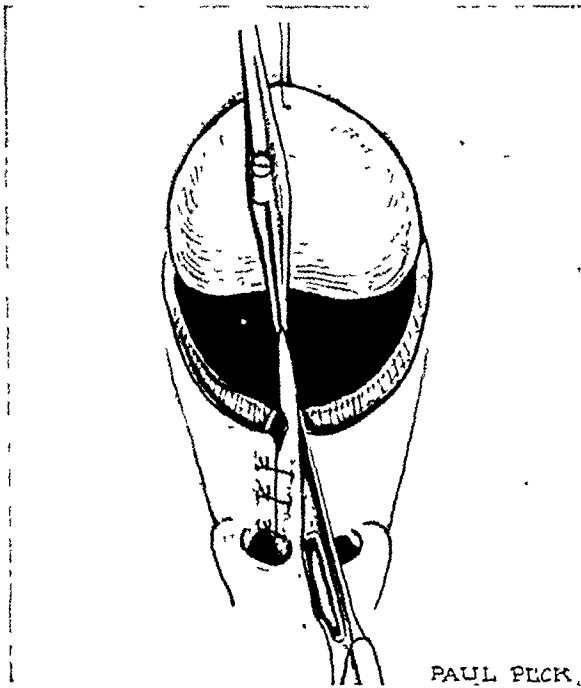
FIG. 7.—Tabs from margin of cleft divided at an obtuse angle leaving enough tissue to produce a slight pouting.
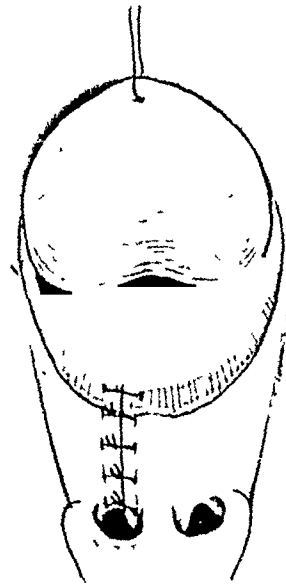
FIG. 8.—Operation completed.

are accompanied by a complete cleft of the palate; therefore the normal curve of the alveolar process must be restored before attempting the repair of the lip. Thompson has pointed out the practicability of moulding the alveolar arch at an early age, two to four weeks, and Vaughan has advocated retaining it in place by means of silver wire. We have adopted these methods as a routine. After anæsthetizing the infant, gradual pressure is made on the unaffected side of the alveolus and it is surprising how easily it can be moulded around until the edges of the cleft in the alveolar process are approximated and the normal curve restored. This procedure also corrects the deviation of the columella which has been previously directed toward the normal side. The edges of the alveolus are now denuded and silver wire of 18 or 20 gauge is passed through the alveolar process well above the tooth follicles, about one-half inch either side of the cleft. An assistant presses the edges of the cleft together and the wire is twisted tightly enough to keep

the surfaces approximated. In older children it may be necessary to divide the alveolar process with a thin-bladed osteotome. The lip is repaired at the same time and it is surprising how easily the margins are brought together without tension, after the normal curve of the alveolar arch has been restored. If the moulding of the arch has not entirely corrected the deviation of the columella, its attachment to the bone must be divided so that with the reconstruction of the nostril it may assume its normal direction. (Figs. 9 and 10.)

Double Hare-lip.—Complicated by the presence of the pre-maxillary bone. In this type of case, the pre- or inter-maxillary bone protrudes like a snout and must be returned to its normal position before attempting closure of the lip. A quadrilateral piece is removed subperiosteally from the vomer to allow reposition of the inter-maxillary bone into the cleft of the alveolar process,

FIG 9 —Moulding of alveolar process
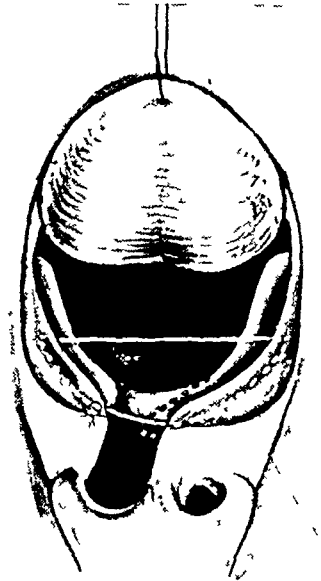
FIG 10 —Silver wire passed through alveolar process and edges of cleft approximated (The artist failed to indicate by dotted lines where the alveolus was transfixed)

the pre-maxilla being pushed back into place and held with a silver wire. The latter is passed in a similar manner as in the cure of a single cleft. In the resection a quadrilateral-shaped piece is preferable to a triangular as the latter would cause the future incisor teeth to tilt backward rather than directly downward. The prolabium is pared quadrilaterally if there is sufficient tissue after transfixing and denuding the clefts on the labial sides to bring the flaps of skin and mucous membrane together beneath it. If this is not possible a triangular section is made and the edges of the lip approximated in a vertical line beneath the apex of the triangle. (Figs. 11, 12, 13 and 14.)

Some authorities advise interposing the prolabium between the denuded edges of the lip so that the vermilion border of the prolabium is continuous with the vermilion border of the sides of the lip, on the theory that the prolabium will develop as the infant grows and thus correct any irregularity which may exist following the original operation. We have not been able to

prove that this plan is feasible and any traction on the prolabium will of necessity increase the flattening of the nostrils which is already aggravated by forcing the pre-maxilla back into the cleft in the alveolus.

We have had a few cases of our own and have seen some which have been operated upon by other surgeons in which the upper lip was much flattened and contracted. These usually followed double clefts of the alveolus, espe-
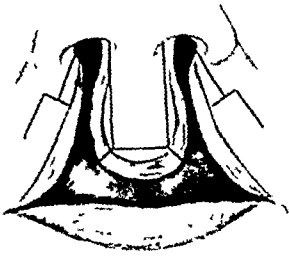

FIG. 11.—Schematic outline of incisions for double hare lip. Prolabium pared quadrilaterally.
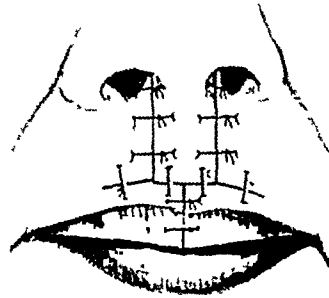
FIG. 12.—Flaps from cleft sutured beneath prolabium.

cially if the inter-maxillary bone had been damaged or removed. To overcome this deformity we have resorted to a method devised by the late Doctor Abbe, who recommended making a vertical incision in the mid-line of the upper lip and filling in the defect with a V-shaped pedicle flap from the lower
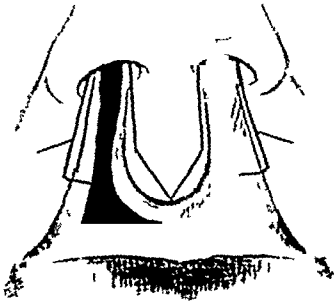
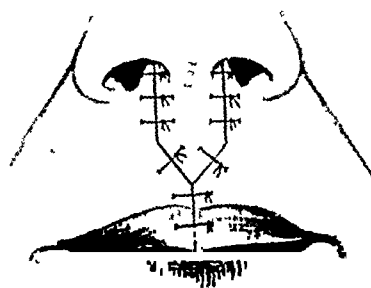FIG. 13 —Schematic incision for double hare-lip with triangular paring of prolabium.

FIG. 14.—Edges of cleft sutured vertically beneath apex of prolabium.

lip. After incising the upper lift in the mid-line nearly to the septum and estimating the amount of tissue necessary to fill in the defect, a V-shaped flap is outlined in the lower lip. Starting at the mucous membrane one centimetre to one side of the mid-line the incision is carried obliquely downward and inward for a distance equal to the length of the incision in the upper lip. The opposite side of the V-flap is now cut upward and outward, stopping at a point before the inferior coronary artery is reached. The location of this

vessel is easily ascertained from its position on the opposite side, which has already been divided. This flap of lower lip is now swung on its pedicle so that the apex of the V is inserted into the apex of the defect and the adjacent raw surfaces sutured. The incision in the lower lip is now partially closed and a suture is passed through the two lips on the pedicle side to insure immobility of the flap. Feeding is carried out through a tube between the lips of the opposite side. In ten days to two weeks' time the pedicle is divided, the lower lip revised as much as is necessary to obtain an accurate approximation and the mucous membrane of the flap sutured to the mucous membrane of the upper lip after any necessary revision.

Cleft Palate.—Many operations have been devised for the cure of cleft palate. Brophy's method of forcibly approximating the two maxillary processes and holding them together with metal plates and silver wire at an early age has been generally discarded. Aside from the fact that many tooth buds were destroyed this method in no way restored the normal alveolar curve and led to a narrow and contracted arch. Lane's operation of hinging a flap from one side and interposing it between the muco-periosteum and bone of the opposite side with an elaborate and complicated procedure on the soft palate was ingenious, but it of necessity led to a rigid soft palate and occasional shrinkage so that the end-results, as far as speech was concerned, were disappointing. We used this method in a few of our earlier cases but have long since given it up. Dorrance, who has recently described a method of lengthening the soft palate by sliding the muco-periosteal flaps of the hard palate posteriorly, having fractured the hamular processes, feels that if the soft palate has been sufficiently elongated and relaxed it will insure satisfactory closure of the nasopharynx and permit satisfactory speech. We have not tried this method, but believe that it may hold great promise. The majority of surgeons feel that Langenbeck's operation gives the most satisfactory results and it has stood the test of time. There are many modifications of his technic; in fact every surgeon proceeds in a different way but the principles remain the same and we have employed it in practically all of our cases.

The successful closure of any cleft palate depends on approximating the tissues without tension. This can be done only if the arch of the palate is of sufficient height to allow the flaps when freed to drop down so that their edges may be approximated; second, by making sufficiently long relaxing incisions on either side just within the alveolar process to allow the edges to be brought together without tension; and third, to relieve all strain on the suture line by holding the flaps in apposition during the healing period by silver bands or other mechanical devices passed through the relaxing incisions.

Complete Cleft Palate.—Lateral incisions are made through the muco-periosteum mesial to the alveolar process on either side of sufficient length to allow suitable periosteal elevators to be introduced and the muco-periosteal flaps separated from within inward until the cleft is reached. Bleeding is easily controlled by packing. On reaching the cleft the elevator is pushed

through the margins of the flap. We prefer to start the separation through the lateral incisions rather than from the edges of the cleft as we feel by this method there is less traumatism to the tissues at the edge of the cleft which must be sutured. The attachment of the soft palate to the bone is divided with curved or right-angled scissors and then we are able to estimate how easily the two flaps can be approximated and, if the soft palate is sufficiently relaxed, to reach the posterior pharyngeal wall. This relaxation is essential to prevent subsequent regurgitation of food into the nasopharynx and to insure speech approximating normal. The edges of the cleft in the soft palate are pared with a sharp thin-bladed scalpel. The margins of the cleft in the hard palate are already denuded by the above method of separation but irregular or frayed edges should be revised. If the flaps are not easily approximated the liberating incisions can be carried more posteriorly and if necessary around the maxillary tubercle. Secondary relaxing incisions are made in the soft palate and two metal bands of silver, as advocated by Vaughan, are passed through the incisions, the first through the incisions in the soft palate and the second through the incisions in the muco-periosteum. The edges of the flaps are now sutured with interrupted transverse mattress sutures which begin at the uvula, one or two being passed through its superior surface. This method of closure secures approximation of the entire thickness of the flaps with accurate approximation of the mucous edges. If there is difficulty in closing the anterior part of the cleft this may be left until a later time. (Figs. 15, 16, 17, 18, 19, 20, 21, 22 and 23.)

The operation is completed by suturing together the ends of the metal bands. We believe these bands serve several useful purposes: 1. Tension is removed from the suture line. 2. The individual's tongue is prevented from pressing directly on the suture line. 3. The strain on the suture line is prevented from early adhesions which form between the muco-periosteal flap and bony palate. 4. The silver bands exert to some degree an antiseptic action in a field rich in contamination.

The method of closure of incomplete clefts is similar to that of the complete. If only the soft palate is involved the separation should be started in the muco-periosteum of the hard palate to allow the latter to drop down, thus relieving the tension and facilitating the division of the aponeurosis attaching the soft and bony palates.

If it has been impossible to close the anterior part of the cleft at the original operation, or as not infrequently happens in our experience, the anterior portion has failed to unite, the resulting sinus may be rather inaccessible due to the fact that it lies at the apex of a funnel-shaped depression. While liberating lateral incisions with separation of the muco-periosteum will usually give sufficient relaxation to allow the introduction of the sutures, we prefer to approach this problem by the following method. An incision is made in the muco-periosteum, at right angles to the aveolus in the region of the first molar tooth, long enough to allow the introduction of a suitable periosteal elevator; the muco-periosteum is then separated
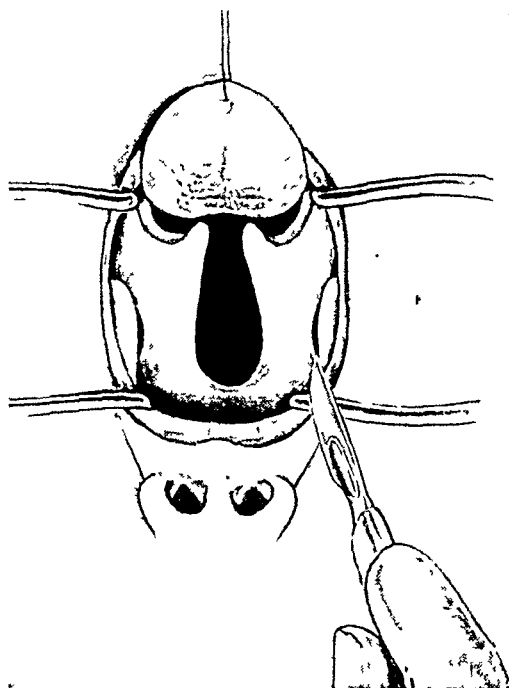
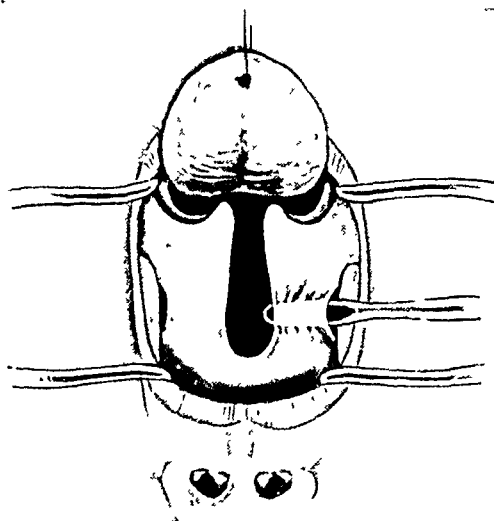FIG. 15.—Lateral incisions through muco-periosteum mesial to alveolar process.

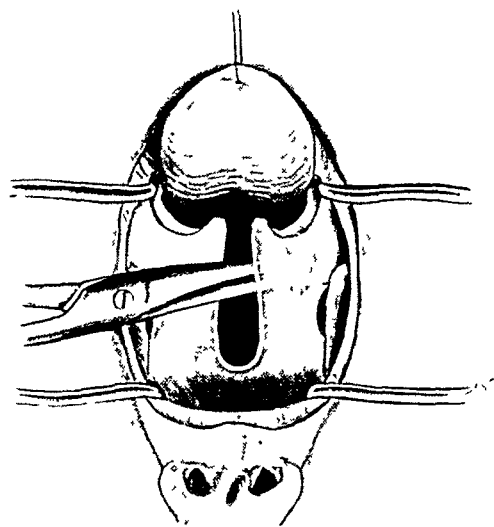FIG. 16.—Separating the muco periosteal flaps from without inwards.

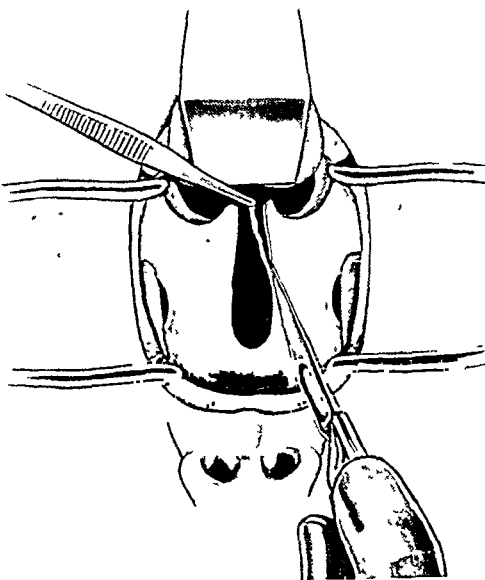FIG. 17.—Division of attachment of soft to bony palate.
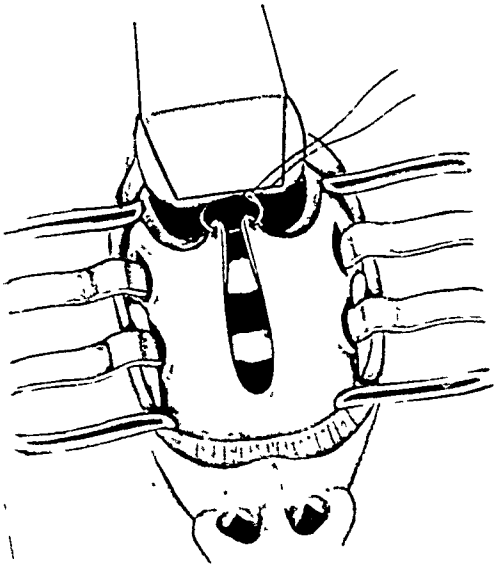
FIG 18.—Paring the cleft of soft palate.

FIG. 19.—Additional relaxing incisions in the soft palate and insertion of silver bands. First suture in uvula.
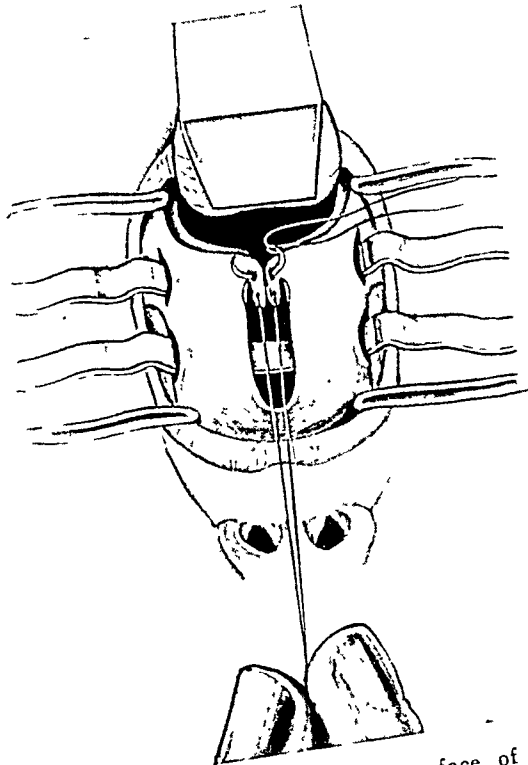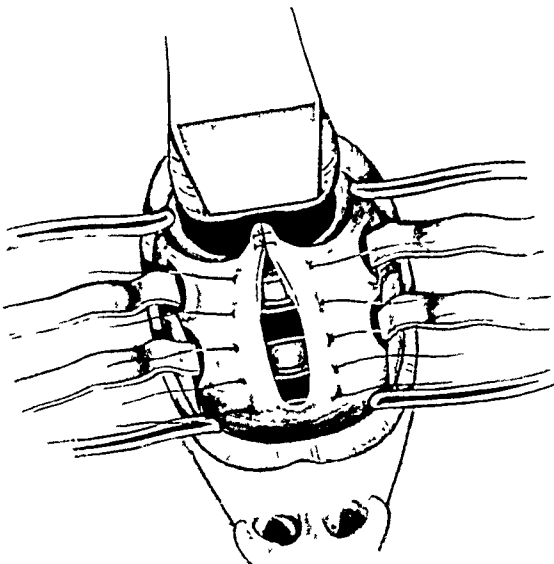
FIG. 20.—Suturing superior surface of uvula.
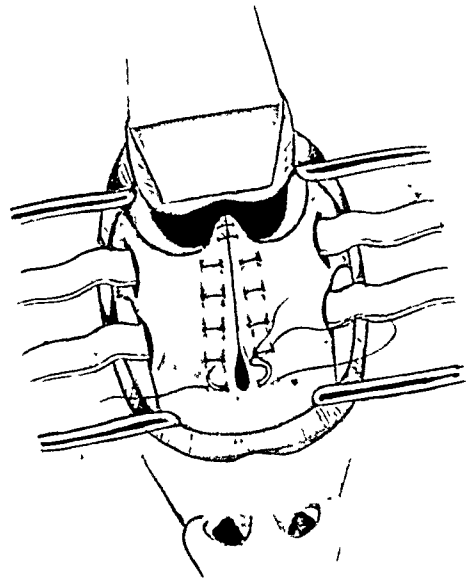
FIG. 21.—All sutures introduced.

FIG. 22.—All but last suture has been tied. The latter shows the completion of the horizontal mattress suture.

from the teeth and palate around to the opposite side, thus forming a semi-circular flap which drops down, making the opening easily accessible. The edges of the sinuses can then be denuded and the sutures easily inserted and tied without causing tension after which the flap is returned to its normal position where it remains without additional mechanical aid. (Figs. 24, 25, 26, 27 and 28.)

Post-operative Care.—1. The foot of the bed is elevated to aid in the discharge of blood and mucus.

2. A hypodermocylsis of saline or glucose solution is given after the patient has reached the ward, the amount depending on the age of the child.
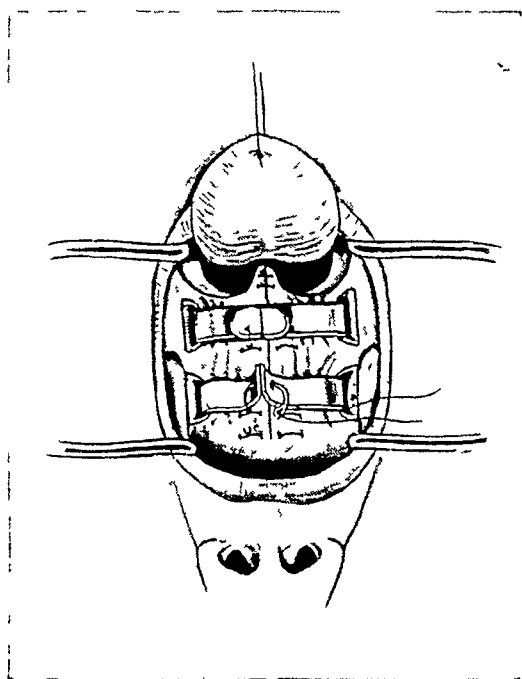
3. The hands of the patient are restrained until the sutures are removed.

4. The pulse is taken every fifteen minutes for the first two hours and the temperature every hour for the first two days.

5. The nose is kept clean to prevent the discharge from getting into the suture line in hare-lip cases.

6. Feeding (*a*) about two hours post-operative the patient may have small amounts of sterile water through a medicine dropper or a Breck feeder. Nothing but water is allowed for the first two days and the nurse gives as much as the child can tolerate.

FIG. 23 —Operation completed by suturing the metal bands

(*b*) Orange juice, strained thoroughly, milk, and other liquids are given with a medicine dropper or Breck feeder on the third post-operative day and the child is not allowed to nurse from the breast or nipple for at least two weeks. No solid food is permitted until the sutures are removed.

(*c*) The mouth is irrigated with normal saline or boric acid after each feeding.

The sutures are removed in seven to ten days in the patients with hare-lip; the silver wire through the alveolus in two weeks.

In the cleft palate cases the metal bands are removed between the tenth and twelfth day and the sutures soon after.

Results.—The results in the cases with hare-lip are usually satisfactory. Occasionally some irregularity of the vermilion border may result which will have to be corrected at a second operation. The reformed nostril is occasionally too large and there may be a flattening of the ala nasi, but as we have gained in experience, paying more attention to the reforming of the floor of the nostril and making a more radical separation of the attachment of
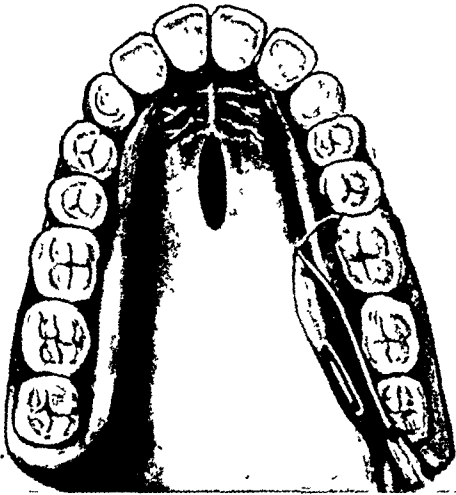
FIG. 24.—Incision in muco-periosteum at right angles to first molar tooth.
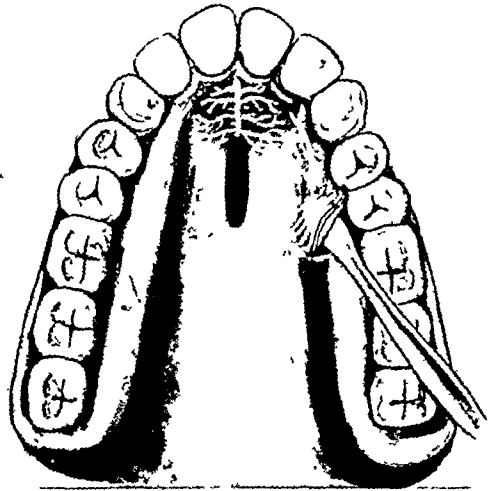
FIG. 25.—Introduction of periosteal elevator. Separation of muco-periosteal flap started.
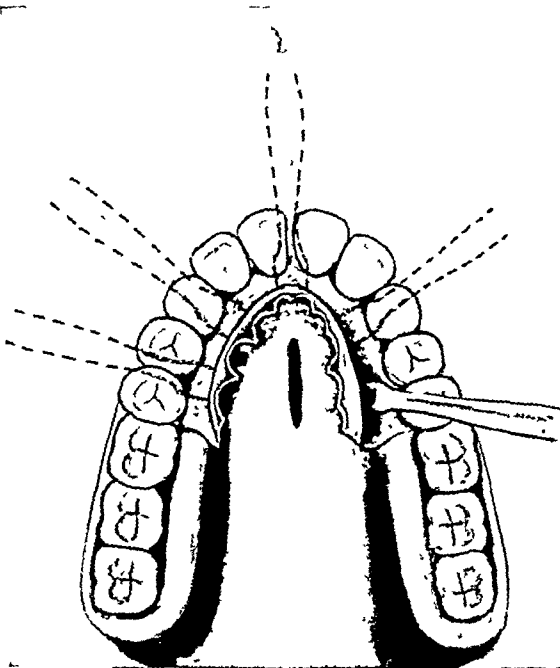
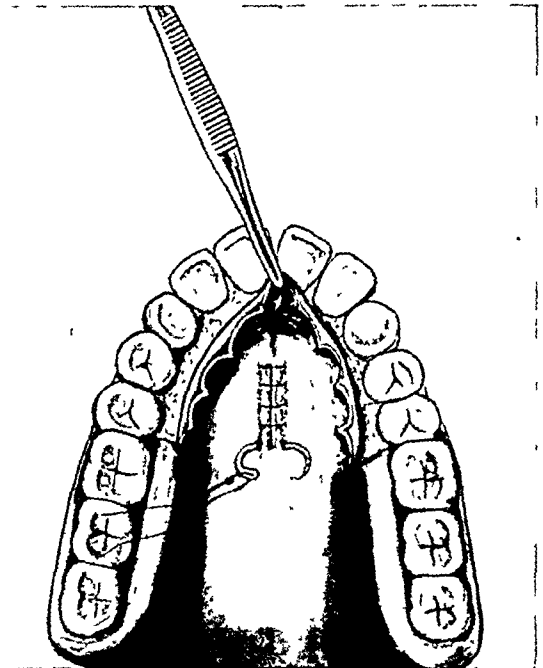FIG. 26.—Separation of muco periosteal flap around to opposite side.

FIG. 27.—Margins of sinus have been pared. Sutures introduced and flap returned to its original position.

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the ala to the maxilla, the cases requiring secondary revision are much less frequent.

Repair of Hare-lip.—(*a*) Unilateral complete hare-lip:

Single operation...............good............... 12

    (not re-operated)........... improved........... 2

Two operations... first one fair, final result good.... 5

Five operations... first one failed, last result good.... 1

(*b*) Unilateral incomplete hare-lip:

Single operation............. good............... 20

improved........... 1

Two operations...first one fair, final result good.... 4

(*c*) Bilateral complete hare-lip:

Single operation............. good................ 2

improved........... 1

Two operations.............. fair................. 2

Three operations.............fair................ 1

(*d*) Bilateral incomplete hare-lip:

Single operation............. good............... 1

improved........... 2

(*e*) Previously repaired hare-lip:

Single operation.....Unilateral........good........ 6

Bilateral........good........ 1

(*f*) Hare-lip, no description given......good.... 1

Repair of maxilla or alveolus alone........................good.... 1

improved .... -1-

The end-results in the cure of cleft palate are most discouraging. In twenty-three patients with incomplete clefts, which are undoubtedly the easiest to cure, we had only nine good results. Five others were classified as poor and nine were improved, which means that they were left with a small sinus or some separation of the soft palate.
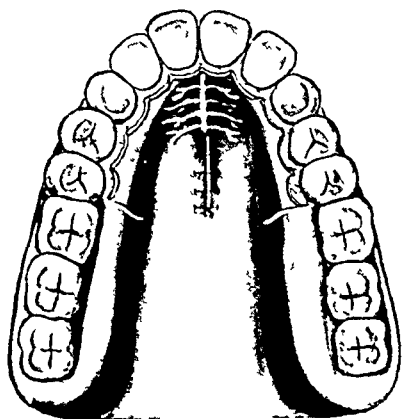
The results were poorer in those with complete clefts. Twenty-two patients were operated upon with only six good results and the majority of these required more than one operation. Eight were improved and seven were classified as poor, which meant a complete failure. Many of these were operated upon at too young an age, others had too wide a cleft and a fair proportion of the children came to us early in the series before we had acquired sufficient experience. Since us-

Fig 28 —Operation completed.

ing the metal bands our results have improved but they are still far from satisfactory.

Repair of Cleft Palate.—(a) Incomplete cleft palate:

Single operation...........good............... 8
improved........... 4
poor................ 4
Two operations...........good............... 1
improved.......... 4
poor............... 1
Three operations.......... improved........... 1

(b) Complete cleft palate:

Single operation...........good............... 1
improved........... 4
poor............... 4
Two operations...........good............... 3
improved.......... 1
poor............... 2
Three operations..........good............... 1
improved.......... 2
poor............... 1
Four operations...........good............... 1
improved.......... 1

(c) Previously repaired cleft palate:

Single operation..........good............... 1
improved.......... 1
poor............... 1

(d) Cleft palate, no description given:

Single operation..........poor............... 1
Two operations........... improved........... 1

Repair of Hare-lip and Cleft Alveolus.—(a) Unilateral hare-lip and cleft alveolus:

Single operation.... good........ 14
improved.... 4
poor........ 1
Three operations.... poor........ 1

(b) Bilateral hare-lip and cleft alveolus:

Single operation.... good........ 3
Separate operations on lip and alveolus ....good........ 4

Deaths.—Nine patients died within the first twenty-four hours. Six of these were operated upon for cleft palates at ages varying from eight months to four years. All of these had temperatures ranging from 106° to 108°. We assumed that this sudden fatal termination with hyperpyrexia was due to aspiration of blood, but in one patient who was autopsied, the lungs were found to be clear. No other clinic has mentioned similar catastrophes and we are at a loss to explain this condition, unless it is due to absorption from the traumatized surface of the separated muco-periosteal flaps. The other three deaths were in cases of hare-lip in two of which the alveolus was moulded and wired. Two of these patients had high temperatures, the eti-

ology of which is as obscure as in those with cleft palate. Nine deaths occurred three to twelve days post-operative, the majority from pneumonia and ten patients died within two or four weeks from malnutrition.

There was a total of twenty-eight deaths in the 139 patients operated upon. Of these eighteen were directly due to the operation and in ten others it is fair to assume that they were not in proper physical condition to stand surgical intervention, inasmuch as they died in two to four weeks' time from malnutrition. Better judgment in the selection of these ten cases might well have eliminated the majority of these deaths.

In studying the pre-operative and post-operative mortality, we have endeavored to prove that a certain proportion of patients (12 per cent.) will die before their physical condition permits any operative procedure to be considered. A certain number will die from the operation (10 per cent.) and unless extreme care is exercised in selecting the ideal time for the operation there will be an additional mortality from malnutrition (6 per cent.).

Speech.—As stated before, all these children must be labored with both by parents and teachers trained in the correction of speech defects. With a little instruction the parents can readily learn to teach the child how to pronounce the more difficult letters and words and we have had some very gratifying results, even in those cases in which the palate was rigid and contracted. The improvement is obvious in adults, who are fairly intelligent and will make the effort to attend a school for speech correction.

CONCLUSIONS

(1) The lip and alveolus should be repaired as soon after birth as the infant's physical condition will permit.

(2) Operations on the palate should be postponed until the child is at least three years old. Do not operate before the cleft is narrow enough to assure reasonable success irrespective of age.

(3) Early closures of the palate do not facilitate correct speech in our opinion, and just as satisfactory phonation may be obtained in the late closures if the individual receives the proper training.

(4) A good cosmetic result is possible in nearly every case of hare-lip providing the parents will not lose confidence in the surgeon if the first operation proves unsuccessful.

(5) The results in the operations for cleft palate are far from satisfactory. Selection of the ideal time as regards age and width of cleft will avoid a certain number of failures.

For discussion see pages 136-140.

PLASTIC RESTORATION OF THE ŒSOPHAGUS

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As far as I can learn, forty-nine cases of plastic surgery of the œsophagus have, up to this time, been described in medical literature. Many surgeons have operated with various methods. The first operation of this kind was made by Bircher and Roux, who devised two principal methods of making an artificial œsophagus. Roux, in 1907, made a complete œsophagus from the thin gut and, carrying it out under the skin of the breast, joined one end with the stomach and the other end with the remaining portion of the natural œsophagus which he had prepared in the neck. This case was successful. Bircher tried to make a complete œsophagus from the skin of the anterior breast wall, but as his patient was suffering from cancer, Bircher lost his patient before the operation was completed.

These two attempts encouraged research for new ways of modifying this particular operation. Instead of the thin gut other organs were tried, i.e., the thick gut and the stomach (Hæker-Kirschner). A complete œsophagus was made from skin and, again, part of the œsophagus was made from the skin and the rest from the abdominal organs (Lexer-Blanel).

I do not wish to describe these operations, interesting though they may be. I wish here only to describe my own case, which was made after Jianu's method with Rutkowski's modification, a method which has not yet been described in medical literature.

As we know, Jianu, in order to make an artificial œsophagus, also used part of the stomach, namely, the large curvature. He separated the stomach from the transverse colon by tying the ligamentum gastrocolicum. The large curvature, which was separated from the rest of the stomach by two forceps, was severed in the region of the pylorus and gradually cut toward the cardiac. The severed part of the stomach with its artery, i.e., gastro-epiploica, on the left side, was reversed to make a tube and was sewed and carried out under the skin in the region of the neck. The remainder of the stomach was simply sewed in the ordinary way.

Rutkowski modified the method of Jianu in the following way. He made the tube from the cardiac side so that this tube was nourished by the arteria gastroepiploica dextra. A tube constructed in this way from the right side is better fitted than the one from the left side—Jianu—because the arteria gastroepiploica dextra is larger and, what is in my opinion more important, the apex of the tube is made from the cardiac part of the stomach where the mucous membrane has not the same peptic qualities as that from the pyloric region. I emphasize the importance of this because the union of the two tubes is facilitated by the fact that ulcers do not appear at the junction of the tubes.

CASE.—W. K., aged eighteen, June 6, 1925, drank hydrochloric acid. She drank, as she herself related, four mouthfuls. Immediately afterward she drank cold water. Next day she vomited with blood. For the next three months she was treated in the hosp'tal for internal diseases During the first month a constriction appeared in the gullet and in hospital they tried to dilate this constriction, with a sound. She could swallow fluid food only with great difficulty. During the first year of treatment her condition fluctuated greatly. Sometimes she could swallow fluid food with ease and at other times she could not even swallow water.

June 20, 1926, she was admitted to hospital. The exploration of the œsophagus with the probe showed that the constriction was 18 centimetres from the teeth. At this point the 6.8 millimetre probe stopped. X-ray examination showed that the barium in the œsophagus stopped at the point of the jugulum. (Fig. 1.) We see the dilation of the œsophagus as large as a pigeon's egg, and from this point the barium flows in a thin stream to the stomach.

FIG. 1 —The photograph shows the point of constriction of the œsophagus.

FIG. 2 —The photograph shows the Jianu Rutkowski operation demonstrated on a specimen stomach

On the day of admission to hospital her weight was only thirty-seven kilograms, mainly because of inadequate feeding. For several days she had to be prepared for operation with injections of sugar and heart stimulants. June 25, 1926, I began to operate under ether anæsthesia. The abdominal wall was opened in the middle line above the umbilicus. The stomach was not large. First I separated the ligamentum gastrocolicum and the ligamentum gastrolienale from the stomach. Then I fastened the forceps on the stomach parallel to the large curvature, and in the direction of the pylorus. Then I cut the large curvature, both anterior and posterior walls, gradually sewing both stomach and large curvature, which was partially cut away from the stomach, and which I reversed to form a tube. This tube was supplied by the arteria gastroepiploica dextra.

Rutkowski made this operation four times, Jianu once, and I also once, and gangrene of the new tube occurred in none of these cases. This is contrary to the experience of Hesse, who took the tube from the left side of the

large curvature. I must emphasize that the stitching of the tube must be done very accurately so that a constriction may not occur in the new œsophagus. It is also very important to liberate the pylorus so that the stomach may be raised and the new œsophagus carried higher up under the skin. Before carrying the tube out underneath the skin it is important to close the apex of the tube very carefully so that infection does not occur. For this purpose I made a channel under the skin on the breast bone with an opening at the junction of the third rib (left side) and the breast bone, and sewed the apex of the tube to the skin of the opening.

The abdomen was sewed in the normal way and the stomach fixed at the top of the opening to the peritoneum. After twenty-four hours, the apex of the tube was opened

Fig 3 —Appearance of the patient two weeks after gastro œsophageal plastic.

Fig 4 —The diagram shows the patient after the second act of operation The two openings of the œsophagus are connected by the rubber drain.

and a rubber drain was put into it and the feed ng of the patient was now begun. Fluid food was easily absorbed by this means and the patient soon lost the feeling of hunger which she had constantly felt during the preceding months.

The patient recovered quickly from the operation. The very small rise in temperature, which was never above 38°C., disappeared after one week. The wound healed well and ten days after the operation the stitches were removed.

November 10, 1926, the second act of operation, left-sided cervical œsophagostomy, was carried out. Under ether anæsthesia, a skin incision was made along the anterior edge of the sternocleidomastoid muscle, which was moved back. As the thyroid gland was abnormally large and hindered the separation of the œsophagus, the left lobe was removed. After this had been done, the œsophagus could be more easily separated and moved toward the wound. The edges of the skin were sewn to the

œsophagus and the œsophagus itself in this act of operation was not opened; but the wound was filled with gauze so that it remained quite aseptic.

After two weeks, when the edges of the wound had grown firmly to the œsophagus and the stitches had been removed, the œsophagus was opened to the length of 4 centimetres. At the same time a rubber drain was inserted in the opening of the new œsophagus.

At this stage the patient could feed herself. She could drink fluids and eat solid foods, meat, vegetables, etc. The patient improved both physically and mentally, and, being now able to eat and drink without assistance, she recovered her good humor and interest in life. January 2, 1927, her weight was fifty kilograms.

June 9, 1928, the third act of operation was performed. The purpose of this was to connect the two openings with a tube made from the skin of the anterior breast wall. The distance between the two openings was 14 centimetres. For this purpose a skin incision was made, one fingerbreadth to the right of the two fistulæ. From this first incision were carried two other incisions across, one a fingerbreadth above the upper opening and the other a fingerbreadth below the lower opening. The two cross incisions were connected on the right side of the two fistulæ so that the upper end of the patch of skin was three fingerbreadths in width and the lower edge four fingerbreadths wide. This patch of skin was separated along the left side to the middle. Then it was reversed to form a tube and was sewn with the right edge. For stitches only fine catgut was used.

Fig. 5.—The patient one month after completion of operation.

Before this skin channel was closed a rubber drain was put through the nasal aperture into the stomach, and by means of this tube the patient was fed after the operation. So there was made a closed tube with the skin reversed containing two fistulæ. Both the exterior wall of this tube and the wound from which the tube had been made were covered with skin taken from the neighboring area. The edges of the skin were first prepared and then sewn over the tube. After this operation the patient was feverish during one week, the evening fever being as high as 39°C. Pus came out between the stitches. Unfortunately, the stitches were taken away too early and after ten days all the cylinder had unrolled.

In order to have material for a repetition of this operation, I was obliged to sew the patch of skin back into its former position. The patient was sent home for some months and during this time the skin was massaged. Soon its former elasticity and movement reappeared. In this way I procured the *status quo* for my next operation.

April 15, 1929, the plastic operation was repeated and the channel was again made from the skin in the same manner as before. Before the channel was covered by the neighboring skin and sewn over, two perpendicular incisions were made on both sides of the breast. In this way the skin was given more play and was not so tight over the channel. After this operation all the channel grew together well save for one small fistula which appeared at the connection of the skin channel with the œsophagus made from the stomach; but this after some time also healed up and disappeared.

After this operation the patient was feverish during two weeks so that the evening

temperature was 39°C. This necessitated a skin incision on the side of the channel a little below the clavicle, and another incision at the point of junction of the channel and stomach. Through these two incisions a little pus and some gangrenous fat came out. A month later the upper wound had healed well but the other persisted. Here there formed a fistula 5 millimetres in diameter which was covered both inside and out with skin. September 4, 1929, with local anæsthesia this fistula was sutured, and by October 1 the wound had healed completely.

It is clear that such a channel made from skin and connected on one side with the œsophagus and on the other with the stomach could not heal *per primam intentionem* because of the fact that both from the œsophagus and the stomach infectious materials pass into the channel—saliva from the mouth and food from the stomach. In order to avoid this infection, the external

FIG. 6.—X-ray of new œsophagus, barium filled.

FIG. 7.—The stomach filled with barium. The œsophagus is partly filled and the barium then passes into the duodenal part of the stomach.

stitches in the skin over the channel must be put far apart and not too tightly drawn. As I have mentioned above, the first attempt at making the channel was unsuccessful. This was undoubtedly due to the fact that the operator had not make the two incisions so as to give more liberty to the skin, and thus the stitches were too tight. This, together with the collection of pus, which in this case was quite normal, caused the unrolling of the skin cylinder. For these stitches only very fine wire was used.

Two years and two months after the first day of operation, the artificial tube was completed. (Fig. 5.) During this time four operations were made under ether anæsthesia and one minor operation under local anæsthesia. This is, of course, a long time for such an operation, and it is certain that this operation could be performed in a shorter time. The period of time between two acts of operation in my case was too long. The state of the patient did

not necessitate these long intervals; they were caused by other reasons which need not be mentioned here.

Three months after completion of the operation, the patient's weight was fifty-five and one-half kilograms. She now took food quite freely, eating meat, vegetables, raw fruits and warm and cold fluids, without any feeling in the skin tube. Histological examination, carried out by Müller on such an artificial œsophagus made from the skin in the case of a patient who died four years after the operation, showed that the skin, while retaining all its anatomical properties microscopically, looked quite smooth and white as if it adapted itself to its new rôle.

The X-ray examination of the new œsophagus (Fig. 6) shows that the barium under pressure of the mouth and throat passes quite rapidly to the point of junction with the stomach tube and there it can be seen that the barium does not stop but continually fills the œsophagus. This proves that from this point peristaltic movement begins.

It would be very interesting to know, (1) what is the deformation of the stomach after the large curvature has been cut away; (2) if the stomach regains its normal shape after some years; (3) if the food goes immediately to the duodenum or if the stomach is first filled with food and then gradually emptied, and, (4) if the food does not stop on the bottom of the stomach, as might be supposed when we remember that the duodenal part of the stomach was turned 90° on the horizontal part of its axis when the stomach tube was put up under the skin. For this purpose I made the X-ray diagram (Fig. 7) which shows that the stomach has its normal contour. It is filled with barium which gradually passes into the duodenum, and two hours afterwards the stomach showed only traces of barium.

THYROGLOSSAL CYSTS AND SINUSES

By Howard M. Clute, M.D., and Richard B. Cattell, M.D.

of Boston, Mass.

FROM THE LAHEY CLINIC

With normal development the thyroglossal tract becomes completely obliterated before birth. When a portion of this tract remains, it may occasionally give rise to a cyst or sinus, and, rarely, to a congenital fistula. Arrest in the development of the thyroid gland may result in this gland remaining in an aberrant location, somewhere along the course of the thyroglossal tract. Very rarely malignant tumors may arise from the epithelium of the tract.

There have been seventy-four cases of thyroglossal tract abnormality treated in the Lahey Clinic up to January, 1930. During this time 6582 cases of thyroid disease were treated. This gives an incidence of approximately one case of thyroglossal tract abnormality to ninety cases of thyroid disease that we have seen. Thyroglossal cysts are probably seen relatively more frequently in a general surgical clinic where fewer thyroid cases are seen.

Diseases of the thyroid gland are now generally well recognized, but abnormalities associated with the origin of the thyroid gland (that is, abnormalities in the thyroglossal tract), have received less attention. Néris,[1] in his prize thesis of 1929, entitled "Le tractus thyréoglosse," has reported the subject thoroughly with particular reference to the cases observed in the Paris hospitals. His book includes a review of the cases reported in the literature, together with a bibliography of nearly 600 references that includes all related subjects. Bailey,[2] in 1929, reported a study of 124 cases seen chiefly in the London hospitals, some of which he had observed personally. Sistrunk[3] reported thirty-one cases from the Mayo Clinic in 1920, and described a new operative procedure for their cure. This operation has come to be widely adopted. Klingenstein and Colp[4] reviewed the subject in 1925 and reported an additional forty-two cases. In addition to these papers there have been several other reviews and case reports.* We plan to report the treatment of these cases in the Lahey Clinic, and to present the results of this treatment from a follow-up study of fifty-eight of these patients.

For an extensive study of the embryology of the thyroid gland we would refer to the excellent reviews by Wenglowski[5] and by Norris.[6] We will briefly recall the origin and descent of the thyroid gland, however, in order that the course of the thyroglossal tract may be sufficiently in mind for the purposes of this paper. The thyroid gland arises as an out-pocketing in the pharynx between the first and second branchial arches. This position is marked in adult life by the foramen cæcum at the base of the tongue. The

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* The authors have reviewed twenty-one additional papers, but these are not included in the bibliography.

thyroid body descends in the mid-line through the tissue which later becomes the hyoid bone, but since the hyoid bone develops at the time of, or after, the descent of the thyroid gland, the thyroglossal tract may vary in its relation to the hyoid bone. It may pass in front of the hyoid bone, behind it, or through its substance. There has been considerable discussion of this point, but for practical purposes it makes no difference in the treatment. Néris,[1] in reviewing the reports on this point, believes that the view that it is anterior to the hyoid is correct. Normally, this thyroglossal tract disappears during fœtal life. When the tract is not obliterated, however, various anomalies occur which depend upon the location and the extent of the thyroglossal duct vestiges.

The rarest anomaly associated with the tract is the failure of the thyroid gland to descend into the neck. The entire structure may never leave its point of origin in the pharynx, and may persist at the base of the tongue as a lingual thyroid gland. We have had two cases in this clinic of proven lingual thyroid gland which have been reported previously.[7,8] Néris[1] was able to find a report of twelve such cases, the first being reported in 1853.

Still-born and non-viable myxedematous babies may have no development of thyroid tissue, and may have only an irregular epithelial cystic mass at the foramen cæcum.[9] In other cases where the thyroid gland has descended into its normal position, small remnants of thyroid tissue have been found in the foramen cæcum. In other rare instances, the thyroid gland descends partially into the neck but never reaches its normal position, and a swelling persists between the thyroid cartilage and the hyoid bone, or above the hyoid bone, which is a solid tumor made up of thyroid tissue. If this is all the thyroid tissue the patient has, removal may result in myxedema as has been previously reported.

The most common abnormality arising in the thyroglossal tract is a simple cyst or sinus. A thyroglossal cyst is a retention cyst resulting from desquamation and inflammation of the epithelial cells in a closed portion of the thyroglossal tract. By recurring inflammation such a cyst may increase markedly in size in a short time, and it is well recognized that these cysts are peculiarly prone to inflammation. This suggests the thyroglossal tract as the portal of entry for the organisms present in the mouth. There is no logical basis for this, however, since in few cases can any direct communication with the foramen cæcum be demonstrated. Thyroglossal sinuses opening in an anterior location in the neck result from the spontaneous rupture of a thyroglossal cyst due to inflammation, or they result from the surgical drainage of the cyst. A true congenital fistula opening into the base of the tongue may occur. Bailey[2] was able to find but two of these that were actually congenital. Néris[1] found six additional congenital cases. Typical history of this fistulous condition, not of the congenital type, was presented by a woman, fifty years of age, who complained of periodic discharge of pus into her mouth. This had been present for four months. On examination a cyst was found present in the supra-hyoid region. Pressure on it caused

a discharge of pus into her mouth, which produced the chief complaint. The discharge could be seen to enter the mouth at the base of the tongue. Bailey[2] reports thirty-two patients with this lesion, including the cases of Freer[10] and of New.[11] The latter was able to demonstrate the communication by X-ray after the injection of a barium mixture. Takeda[12] demonstrated the extent of a fistula by X-ray in 1922. All thyroglossal sinuses and fistulæ opening on the neck are secondary to preëxisting thyroglossal cysts, and for this reason all of these cases will be discussed together. Fifty-eight patients have been followed more than one year after operation, so that this number will be considered in this report.

Sex.—In our experience with thyroid disease the incidence of female to male patients is in a ratio of 7 to 1. In anomalies of the thyroglossal tract, however, this predominance does not exist. Thirty-eight of our patients were females, and twenty-two were males, making the ratio less than 2 to 1. Klingenstein and Colp[4] found thirty-one males and eleven females in forty-two cases, while Bailey[2] found seventy-two females in 117 cases.

Age.—The youngest patient in this series was three years old, and the oldest was seventy-two. The average age for the group was thirty-three years. These figures represent the age of the patients at the time of their first examination.

TABLE I

Age Groups

1–10 years	3	40–50 years	5
10–20 "	7	50–60 "	7
		60–70 "	2
20–30 "	11	70–80 "	1
30–40 "	19	Not stated	3

Duration.—Of this entire group of fifty-eight patients only eight, or 13 per cent., were discovered before ten years of age. One of these was noticed at birth, and another at the age of three months. Bailey[2] states that in ninety-two cases that he reviewed, the greater majority were in babies and infants, while only nineteen of the ninety-two were discovered after twenty years of age. Klingenstein and Colp's[4] experience was similar, with thirty-one of forty-two cases being under twenty years of age at the time of operation.

In forty-one of our cases, the first appearance of the thyroglossal cyst or sinus was noted on the history. In twenty-four of these it appeared after twenty-five years of age, one being found at fifty-seven and another at the age of seventy-one. The duration of the cyst before operation varied from four months to thirty-three years. Thus it will be seen that in our experience this abnormality was usually found in adult life. This is contrary to most reports. It must be appreciated, however, that the greater majority of patients at the clinic are adults.

Pathology.—In this group there were forty-one cysts, eighteen sinuses and one fistula. The size of the cysts varied considerably from tumors which

were barely palpable to one which was six inches in diameter (Figs. 1 to 4).

The contents of the cysts are generally of a mucoid character, but in long-standing cases they may contain necrotic material and cholesterin crys-

FIG. 1.—A small thyroglossal cyst.

FIG. 2.—There is a history of repeated inflammation with rapid increases in size.

tals. When infection is present the contents are purulent, and if the cyst is of long standing its wall is thickened by the repeated inflammatory changes. Osteomyelitis of the hyoid bone may occur, and has been found at operation twice in our experience. In both of these patients there had been long-

FIG. 3.—A large mid-line fluctuant tumor which moved upward with deglutition. A diagnosis of thyroid adenoma was made, but at operation it proved to be a thyroglossal cyst.

FIG. 4.—The lateral view of the patient shown in Fig. 3.

standing infection of a thyroglossal sinus. This osteomyelitis may delay healing and cause a persistent discharge of long standing. It may readily be confusing, since one is lead to believe that all of the tract has not been excised. It is also very disturbing because of the long duration of the marked induration that accompanies it.

Up to the level of the hyoid bone the cavity of these cysts is continuous, as a rule, with the structures of the thyroglossal tract from which it arises. At this point the tract is less obvious, and is often difficult to trace. As stated before, the tract at this point may be in front of the hyoid, behind it, or through its substance.

The microscopic appearance of these cysts is in keeping with their epithelial origin. They are lined with stratified squamous epithelium. Occasionally the epithelium is ciliated, and appears columnar. Following repeated inflammation at times only a fibrous wall may be demonstrated with no evidence of epithelium. In one instance in our experience thyroid tissue was found in the cyst wall. Néris[1] reports a similar case.

The thyroglossal sinuses may be lined with epithelial cells similar to those of the cysts. For the most part, however, these sinuses show simply a very
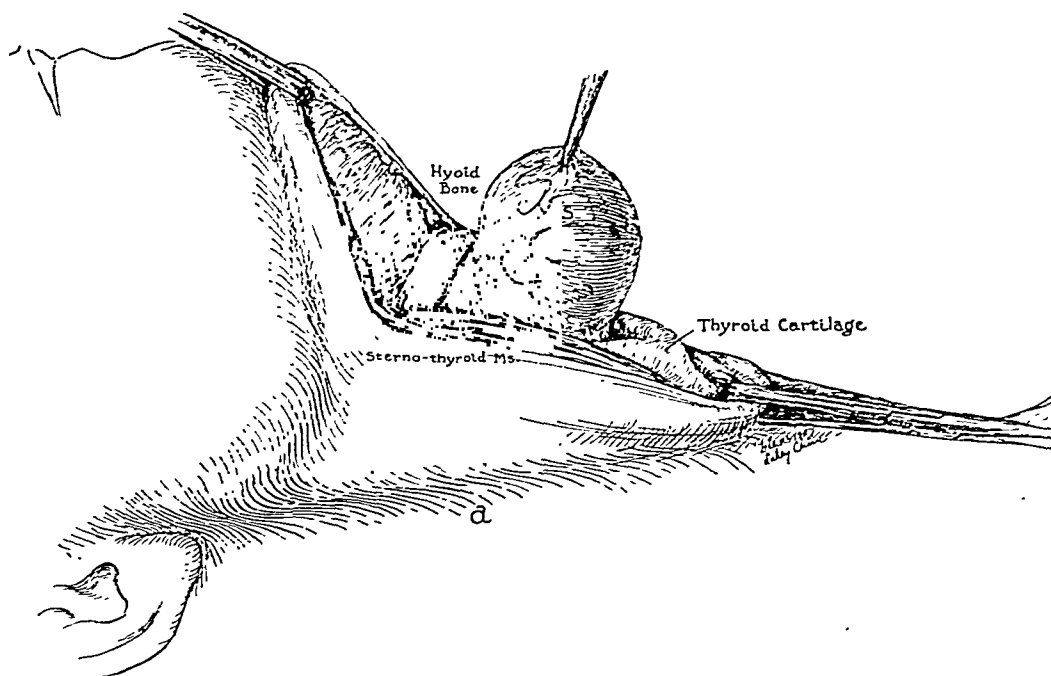

FIG. 5.—Drawing made at the time of operation, showing exposure of the cyst and its relation to the hyoid bone and thyroid cartilage.

marked chronic inflammation, with little or no microscopic evidence of epithelial tissue.

Epidermoid carcinoma arising in the thyroid gland probably has its origin in the thyroglossal tract. The occurrence of this type of carcinoma is quite rare. One such instance of squamous-cell carcinoma has been observed in the clinic[13] and has been previously reported. It is difficult to explain this type of carcinoma, except as arising from the thyroglossal tract vestiges. We have previously operated upon a boy who showed a development of early adenocarcinoma in a thyroglossal cyst. We have been unable to find a report of a similar finding in the literature. A brief report of this case follows.

A boy, six and one half years of age, came to the clinic in February, 1930, with a soft fluctuant swelling in the region of the hyoid. It had been noticed by his mother four weeks previously, when it was about the size of a marble. His mother associated its onset with a blow to this region. The usual radical operation was carried out.

Examination of the specimen showed the tract passing through the substance of the hyoid bone. Dr. Shields Warren reported that the cyst showed the usual epithelial lining, with chronic inflammation, but one portion of the wall showed adenocarcinoma. Sixteen days later the wound was reopened, resecting further portions of the hyoid as well as carrying out a more radical removal of the muscular planes, and Doctor Warren reported these specimens as showing no evidence of the growth. He will report this subsequently.

Location.—The most common location of these cysts is in the mid-line of the neck on the thyrohyoid membrane, lying in the sub-hyoid area. As they increase in size they may acquire an asymmetrical position, and lie to either side of the mid-line at different levels in the neck. Fraser [14] found a cyst incorporated in the hyoid bone to the left of the mid-line. He believes that the primary portion of the thyroglossal tract (that is, the thyrolingual portion) becomes obliterated early, while the portion at the hyoid branches into several buds that deviate from the mid-line. This can explain their position in other than mid-line positions, and is in agreement with the embryological findings of Norris.[6]

In a few instances the cyst has been so low that it was mistaken for an adenoma of the lateral lobe of the thyroid. Bailey [2] reports four instances where the cyst was found in the suprasternal notch. The location of the thyroglossal sinuses is entirely dependent on the original location of the cysts from which they develop, and on the point at which the cysts are incised. In the ninety-two cases reviewed by Bailey,[2] twenty-one were above the hyoid, and seventy-one were below it. We have observed no instance of a cyst or sinus occurring below the normal position of the thyroid. All of the thyroglossal cysts that we have observed have been in close relation to the hyoid bone, or definitely below it. Most of the sinuses have passed above the level of the hyoid, but less than half of them have shown a visible extension upward to the foramen cæcum.

Symptoms.—Subjective symptoms arising in association with thyroglossal abnormalities are almost entirely related to the presence or absence of infection. A simple cyst is noted as a painless, non-tender swelling in the mid-line of the upper neck. Frequently the only complaint is that of unsightliness. When infection is present the cyst becomes tender, red and increases considerably in size. We have not observed the tendency of the infection to pass around the neck as a collar, as reported by Bailey.[2] There may be a considerable enlargement in a few days' time. With inflammation, deglutition may be painful; breathing has not been affected in our experience.

When the cyst is replaced by a draining sinus the constant discharge of mucus is annoying. Not infrequently the sinus heals superficially, and requires repeated incisions on account of retention of secretions and infection.

In thyroglossal fistulæ there are periodic discharges of mucopurulent material into the mouth when the cyst is compressed. In our case it was impossible to palpate the cyst after its contents had been discharged. This was true in the case described earlier in this paper, in which the cyst was palpable on the first examination, and discharged pus freely through the

foramen cæcum. Later examination failed to reveal the tumor previously felt. Operation was advised, and carried out on the basis of the preliminary examination and on the history.

The diagnosis of a thyroglossal cyst is dependent upon its mid-line position and its intimate relation with the hyoid bone, and on the fact that it moves upward with deglutition. These simple findings will establish the diagnosis in most cases. The diagnosis of a thyroglossal sinus depends upon the history of a preëxisting mid-line tumor, which has either ruptured or
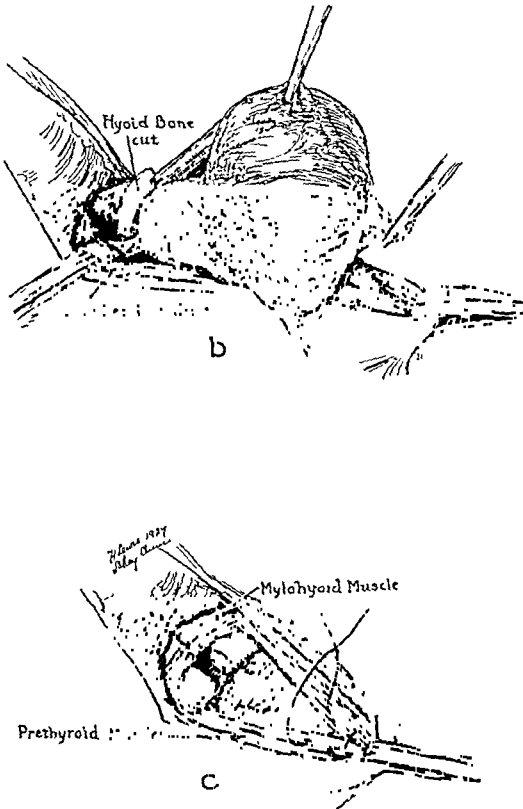

FIG. 6.—The upper drawing shows the hyoid bone divided with the ends retracted. The portion of the hyoid bone that has been excised is not shown. The tract extends upward above the level of the hyoid bone towards the base of the tongue. The lower drawing shows the operative area with the cyst and tract removed with interrupted sutures placed in the muscles. Rubber dam drain is brought out from the depths of the incision and the hyoid bone is approximated with interrupted sutures placed through the fascia and muscles surrounding the bone.
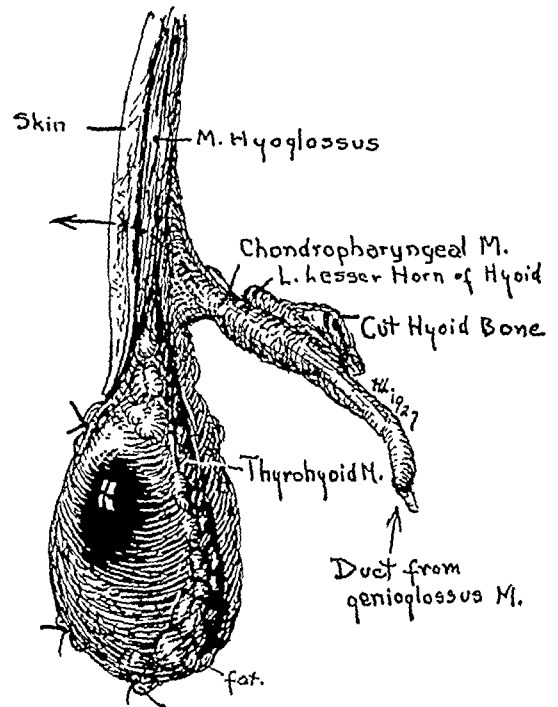
FIG. 7.—A drawing of a specimen of a thyroglossal cyst and its tract which have been removed at operation. In this instance, the tract was a definite structure that was easily followed.

was incised. Thyroglossal fistulæ opening into the foramen cæcum cannot be confused with any other condition. In certain cases it is possible to confirm the diagnosis of thyroglossal sinus or fistulæ by the injection of barium paste, lipiodol, or some other radiopaque substances with the use of the X-ray. In our experience, such a procedure proved painful and unsatisfactory, and it will rarely be necessary to establish the diagnosis.

There are relatively few lesions which occur in the region of the thyroglossal tract that could be confused with these cysts. A discrete tuberculous gland in the sub-mental region has been found a few times in our cases when the diagnosis was thyroglossal cyst. The differential diagnosis of

these two conditions is very difficult on clinical examination, and may be in doubt even at operation.

In a recent case a chronically infected cystic mass occurring in the sub-hyoid region was found, which was very difficult to prove to be a thyroglossal cyst. It did not seem to be attached to the hyoid. Nevertheless, the complete operation was carried out with the removal of the central portion of the hyoid. The pathologist reported it as a thyroglossal cyst. It is quite possible that such a patient would not be relieved by a simple excision.

FIG. 8.—A photograph of an excised thyroglossal cyst which had become a sinus from a previous simple incision. It can be seen that the tract becomes quite small, but that a core of muscular tissue has been removed with it. Arrow points to sinus opening in section of hyoid bone that was removed.

FIG. 9.—The thyroglossal cyst and tract excised from the patient shown in the second figure. It will be seen that a definite tract extended for an inch above the cyst, but that it was necessary to excise muscle tissue above it to the floor of the mouth in order to remove it radically. Results:—Cured.

A thyroglossal cyst has been found in two patients when the diagnosis of discrete thyroid adenoma had seemed assured. The cysts in these cases were in the position of the isthmus, and overlay it. A stalk ascended to the hyoid bone in each case, somewhat in the manner of a small pyramidal lobe. The operative diagnosis depended on this extension of the stalk, and was confirmed by microscopic examination.

Dermoid cysts have been encountered, and cannot be differentiated easily

from thyroglossal cysts before operation. Lipomata and wens might be confused with these cysts but can usually be differentiated. Neither lipomata nor dermoids are apt to move on deglutition.

Operative treatment.—Néris[1] found that Durham, in 1893, suggested division of the hyoid to give better operative exposure. Schlange first practiced resection of the median portion of the hyoid in 1906. The best description of a satisfactory operative technic was devised by Sistrunk[3] and reported in 1920. This is the radical operation which we have employed, and we would refer the reader to his article for the details of his operation. In brief, it consists of the complete removal of the cyst or sinus, the resection of the median portion of the hyoid bone, and the excision of a core of muscular tissue in the plane of the tract, up to the foramen cæcum.

Many methods have been used in the past to identify sinuses at operation. Silkworm gut and probes have been introduced, various dyes have been injected, and radiopaque materials have been used to have X-ray plates in the operating room showing the direction of the tract. The granulation tissue of the tract can usually be identified without these measures, and they all can now be discarded if the technic of Sistrunk is used.

Prior to our examination twenty-five of these fifty-eight patients had been operated upon. Nineteen patients had incision and drainage, among whom three were incised twice, and two were incised three times. Six had excision to the hyoid bone, one patient having three such excisions. It is important to note that in none of these twenty-five cases had a radical operation ever been attempted.

In our operative experience in the Lahey Clinic we have incised and drained four cases, each of which required later radical operation. In five patients excision was carried only to the hyoid bone, and two of these required later radical operation. Thus in our own experience six of these nine patients required later radical operation after the failure of lesser procedures.

End results.—The end results after the radical operation have been most satisfactory. There has been no operative mortality, and there has been no recurrence in the fifty-one patients followed who had this operation. Excision to the hyoid bone alone has proved unreliable, since in the five patients in whom this alone was done reoperation was necessary in two cases. Of the fifty-eight patients in this group, four could not be followed. Four were followed for less than six months, and fifty were followed for more than one year.

In the group of fifty-four patients who were followed, six complained of thickening in the scar. There was in these, however, no evidence of tumor and no discharge. In one patient who had osteomyelitis of the hyoid bone this thickening was one factor in a mental depression that culminated in suicide three months after operation. It has been necessary to excise an unsightly scar in one case.

SUMMARY

1. Thyroglossal cysts and sinuses are of relatively rare occurrence.

2. The diagnosis is made on the findings of a single mid-line tumor or sinus in the region of the hyoid bone, which moves with deglutition.

3. Operation may be advisable for unsightliness, a discharging sinus, and infection.

4. Incision and drainage should be done only in the presence of an acute infection, and with the understanding that later radical excision will be necessary for cure.

5. The radical operation is necessary to assure the cure of the thyroglossal cysts and sinuses. No recurrences followed its use in our experience.

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MULTILOCULAR CYST OF THE SPLEEN
PRODUCED BY INFARCTS

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The diagnosis of certain affections of the spleen not seldom encounters insurmountable difficulties. It often occurs, in fact, that the real nature of a given splenic condition is revealed only by ablation of the organ. Splenectomy at present permits us to determine, with growing exactness, both clinical and anatomical modifications not only in the spleen, but in the liver, undiscoverable by any other method. We are well aware that conditions underlying certain types of splenic hypertrophy are not rendered positively clear, even after puncture of the spleen or removal of its pulp with a trocar especially designed for the purpose, and without mention of the several dangers occasioned to the patient by these procedures. It thus often occurs that, in view of the evident clinical complications, cases of splenic hypertrophy are operated without exact knowledge of the real pathological conditions present.

On account of these facts, some writers think that splenectomy should be done immediately, and without waiting for exact diagnosis, in cases of splenic hypertrophy accompanied by marked pain with no contraindication opposing ablation. Although the type of surgical procedure applicable remains as executed by Viard, in 1851, the indications for ablation of the spleen have been considerably extended during more recent years. In an entire group included under the term "surgical affections of the spleen," splenectomy is beginning to be employed in certain cases of blood diseases and the hæmorrhagic diathesis. Ablation of the spleen constitutes in this respect the most recent advance in modern therapy and is often the only resource for saving the patient's life.

One of the rare affections of the spleen, recognized only with difficulty in two or three cases before the adoption of surgical treatment, consists of cyst. Neglecting cysts of parasitic origin, which are those most frequently encountered, we shall describe the process by which certain non-parasitic cysts of the spleen are formed. Until the present opinions have differed on this question. Now, however, they tend to agree, at least on certain points.

Splenic cysts may be of embryonic origin, as with dermoids; may be referable to an inclusion of the peritoneal endothelium within the spleen, with subsequent degeneration (Hamilton and Boyer); or depend upon polycystic degeneration (Coenen); or constitute lymphatic cysts. Next after congenital cysts come cysts due to circulatory disturbances producing thrombosis of small vessels with consequent necrosis of the splenic pulp, which produces most of the lesions occurring in the otherwise healthy spleen and *a fortiori*

most readily affects the diseased organ and gives rise to hæmorrhages. As the latter become encysted, they may produce hæmatic, serous or purulent cysts. Microscopically, such cysts present various appearances. Some are covered with epithelium or endothelium, which are unrecognizable in other cases. The structure may perhaps be that of pseudo-cysts. Spencer mentions a cystic teratoma of the splenic region.

The question of splenic cysts is allied to that of abscess-formation derived from cysts. Abscess, however, is most commonly caused by infarcts, emboli. etc.; for example, following endocarditis; or abscess may be metastatic in cases of paronychia, pyæmia, typhoid or recurrent fever, dysentery or articular rheumatism (Omi). Cysts of the spleen may be unilocular or multilocular. According to Hamilton and Boyer, they occur oftenest in women (65 per cent. of the cases).

With respect to the site of the cyst within the spleen, small lymphatic cysts are usually distributed discreet'y, large lymphatic cysts are situated at the hilum (Subbotic) and blcod cysts lie nearer the external surface of the spleen. It must be remembered also that cysts may be formed at the surface of the spleen at the site of chronic perisplenitis (*cystis hæmorrhagica vel serosa perisplenica*) or at the extremity of villosities arising from the same tissue (Subbotic).

It appears that the type of lesion has a decisive influence in the formation of a splenic cyst, principally in cases where the spleen is fragile originally. Spontaneous rupture of the spleen is rare. Anatomically, trauma may produce rupture of the spleen when the latter is hypertrophied, the capsule being torn although the trauma may not have penetrated to the interior of the pulp. Pulp extending beyond the borders of the wound forms small hernias (ruptures sèches or the Milzhernien of Schmaus). In cases of this kind, hæmorrhage is insignificant. The effused blood is resorbed or clots which may be formed are organized, all traces of the original lesions remaining only as cicatrices (Janusz). Another anatomical form of the causative lesion consists of splenic rupture extending deeply into the pulp concentrically toward the hilum. This lesion is perhaps caused by considerable escape of blood or by perforation of a softened infarct present in typhoid or recurrent fever, the accompanying complications being extremely grave.

Post-traumatic cysts appear to be larger than isolated cysts. In the literature, splenic cysts are discussed mainly by Coenen, who assigns them to cystic degeneration (polycystische Milzdegeneration). A section of the spleen thus shows a spongy formation containing liquid characteristic of hydrocele, together with fresh blood clots. Absence of complete data prevents a knowledge of the etiology of cyst-formation of this kind. The term employed by Coenen seems to imply that the author assigns such cysts to an organic cause.

Spontaneous rupture of the spleen may be due to engorgement of the stomach, adhesion of the capsule to the diaphragm, the spleen being torn during respiratory movements, or infarct (Janusz). Hæmorrhage of the

spleen may be violent, producing death in a short time. Hæmorrhage may also be periodic or delayed. In fact, there are cases in which one day, one and one-half days, four, nine and even fifteen days, elapsed between the traumatism and the effusion of blood (Kolb). In some cases, the lesion results in separating the capsule from the pulp, with formation of a subcapsular hæmatoma. Böttcher mentions a curious origin of splenic cyst, having found one presenting well-advanced amyloid degeneration. Following amyloid changes occurring in the wall of the main vessel, foci of necrosis are formed which become filled with liquid and which may later become covered with epithelium, but which for the moment are surrounded by a layer of connective tissue.

Cyst of the spleen was first noted by Andral, in 1829, in the course of an autopsy. Péan did the first ablation of a splenic cyst, in 1867.

With respect to the clinical conditions produced by splenic cysts, much pain is a common result. Cases in which such cysts are discovered at autopsy only, and without preceding clinical signs, are extremely rare. Cysts of the pancreas, liver, ovaries and kidneys, hydronephrosis and inflammations and tumors of these structures differ in origin. In no case has any splenic cyst been discovered before surgical intervention. Such cysts may cause a sensation of painful weight in the abdomen, respiratory disturbances, or disturbances of the stomach and colon (chronic colitis) due to pressure and permanent irritation, urinary or menstrual disturbances, or circulatory disturbances producing abdominal effusion and œdema of the legs owing to pressure on the inferior vena cava or left common iliac vein.

Splenic cysts may displace the spleen itself or cause torsion of its pedicle, may produce large adhesions with the anterior abdominal wall or diaphragm, or may cause modifications of the circulation. Such modifications occur in such a way that gigantic vessels of a collateral circulation are produced. Finally, the adhesions or the displacement of the spleen may produce the phenomena of acute or chronic occlusion. Among physical effects may be noted the friction which may be audible at a certain distance from the patient, as mentioned by Monnier. Fluctuation is rare. Blood examination usually shows nothing abnormal.

If we chronologically examine the various methods of treating cyst of the spleen, we remark that internal remedies were at first employed, and that finally treatment has consisted of radical ablation, now considered the only rational therapy. Development of our knowledge of the physiology and pathology of the spleen has permitted the application of bolder and bolder surgical procedures. Treatment of the affection thus consisted at first of the internal administration of iodine. Puncture was next tried. Still later, the cyst, after aspiration of its contents, was injected with a 3 per cent. solution of phenol (Mosler) or adhesion of a part of the cyst wall to the peritoneum was produced. Next, the cyst was opened extra-peritoneally; caustic potash was used to remove eschars of its envelopes (Récamier). Electropuncture was also employed (Magdelain). Simon introduced into the cyst a trocar

bearing an obturator, for aspirating the liquid of the cyst. When the serous surfaces were united, he incised the layers lying between the internal and external orifices. Volkmann applied laparotomy. Introducing phenolated gauze, he produced adhesions and incised the cyst seven to ten days later. Others, like Lindermann and Begin, opened the abdominal cavity and the cyst, suturing the borders of the cyst incision into the laparotomy wound. Some endeavored to ablate the cyst (cystectomy), resuturing the spleen afterward. At present, the only rational procedure applicable to splenic cyst, as with all conditions where operation is indicated, is splenectomy.

Following are the most important data of a personally observed case. The patient, a nun, aged thirty-eight years, had measles during childhood and typhus exanthematica at the age of fifteen. Her menses appeared at the age of fifteen. They were abundant, painful and continued for twelve days. Since that time, menstruation was regular, painful and more or less prolonged. For seven years, at intervals of a few weeks to a few months, the patient was subject to febrile attacks in which the temperature might reach 39° C., to chills, pain in the arms and legs, nausea and anorexia. These symptoms would continue for one to three weeks, would then cease, and would recur later. Three years ago the patient fell from a tree. The fall was followed by severe pain in the sacral and lumbar regions, especially on the left side. The pain prevented stooping forward, the patient remaining in bed for a week. At the end of this time the pain had diminished, though it was still present in the left lumbar region and left hypochondrium. Three months later, in the presence of chills and a temperature of 40° C., violent pain suddenly occurred in the lower part of the abdomen, in the region of the cæcum. Continuous nausea and vomiting, independent of eating, accompanied the other symptoms. These conditions continued for a month. A tumefaction, tender and painful to pressure, was then felt in the left hypochondrium. It was hard, increased in size, finally reached the size of a fist and changed its position according to the position assumed by the patient.

Since the patient entered hospital she complained of pain beneath the ribs on the left side and in the left lumbar region. The pain became more intense after physical effort. Appetite was wholly absent and the patient became extremely feeble. She had become considerably emaciated during the past two years, was persistently constipated, and had no urinary disturbances.

Examination showed no changes in the head or thorax. The abdomen was slightly distended. The left hypochondrium showed some fulness and was sensitive to palpation. McBurney's point was painful on pressure. The liver was not palpable. A tumor was palpable beneath the left ribs, extending to the navel. The surface of the tumor was smooth and elastic, becoming displaced when the patient changed position. The tumefaction in question corresponded to the spleen. The evening temperature was continuously subfebrile. Urinary examination was negative. Stool examination showed numerous ova of trichocephalus dispar and a few of ascaris lumbricoides. Blood examination showed nothing pathological. Since the spleen was found to be movable, the patient was removed from the medical to the surgical service.

Here two supplementary examinations were made, namely, cystoscopy and pneumoperitoneum. Cystoscopy showed slight congestion of the vesical mucosa, with no other changes. Indigo was eliminated intensely from both kidneys in five minutes. Pyelography showed no changes in the contour of the renal pelvis and ureter. The palpable tumor appeared to have no connection with the kidneys. After instituting a pneumoperitoneum, by introducing 100 cubic centimetres of oxygen into the peritoneal cavity, it was noted that the spleen was considerably enlarged. It had become spherical, was displaced during deep inspiration and could be easily impelled toward the pelvis. The röntgen examination similarly showed a mobile spleen.

A substance of great value for preserving the spleen and therefore for the differential diagnosis of affections of this kind consists of adrenalin, which readily attacks the spleen. In our case, injection of one milligram of adrenalin produced no change in the splenic figure. Basing his opinion upon abundant clinical material referring to preservation of the size of the spleen by the ingestion of adrenalin, Stefek formulates the following conclusions:

1. Maximal diminution in the size of the spleen following an injection of adrenalin occurs fifteen to twenty minutes after the injection.

2. In neoplastic or fibrous changes, as in lymphogranuloma, for example, the contractility of the spleen is limited to the unaffected portion of the splenic pulp.
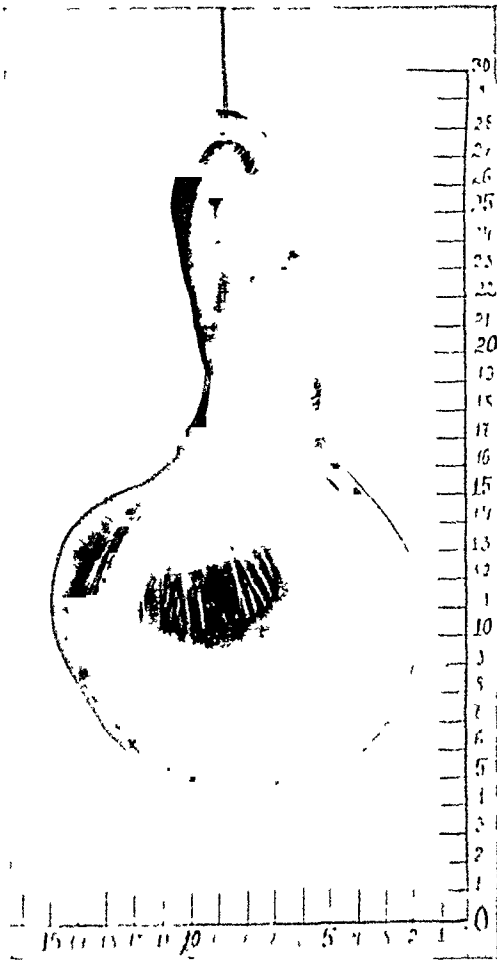

FIG. 1.   FIG. 2.

3. Since the limits of the tumor in the left hypochondrium did not change after injecting adrenalin, blood examination may indicate whether the tumor in question is the spleen, as modified by the disease-process present, or whether it originates from a neighboring structure.

After diagnosticating mobile spleen, operation was undertaken. The splanchnic nerves of the left side were anæsthetized by the Roussel method, the seventh, eighth, ninth and tenth intercostal nerves were rendered insensitive, transverse incision was made through the rectus muscle and the abdomen was opened. It was noted that the spleen was pyriform and that its upper pole was of regular structure, while the lower pole was altered, swollen, of the size of two fists, without adhesion to neighboring parts, the lower parts of the tumor bearing enlarged venous vessels. After ligating the vessels as usual, the spleen was ablated, the wall being sutured in three planes.

The organ thus removed at operation was pear-shaped, measuring 25 by 13 centimetres, the widest antero-posterior diameter being of 14 centimetres (Fig. 1). The

upper extremity presented the structure of normal spleen and was 11 centimetres long and 5 centimetres wide. Well-marked cicatrices were present in the lower extremity and thickened areas in the capsule appeared as extensive spots connected by folds. Distinct fluctuation was present on the anterior surface of the lower extremity. Puncture yielded 140 cubic centimetres of an amber liquid, transparent, and coagulating in a test-tube.

The section (Fig. 2) revealed large cysts not inter-communicating, filled with amber liquid and clots, and having smooth and slippery walls. Section of the upper extremity showed the normal splenic structure. Bacteriological examination of the liquid of the cysts showed that it was perfectly sterile. Microscopic examination of tissue taken from the upper extremity likewise showed normal structure.

Tissue taken from the pulp lying between the cysts and from the cyst walls showed the following conditions: Certain preparations presented a perfectly homogeneous necrotic mass; at other sites, this mass was beginning to soften; the pale structure of splenic tissue occurred at various sites. Amid the necrosed masses, fibrin existed rather abundantly. In parts of the spleen near the necrosed masses, there were a few blood-vessels whose walls were distinctly thickened. Thickening was especially marked in the vascular endothelium, notably diminishing the lumen of the vessel and even obliterating the lumina of small vessels.

The entire microscopic image showed circumscribed necrosis appearing in consequence of obstruction of the large vessels by obliterative endarteritis. A hæmatoma might have been considered present, were not the contrary indicated to some extent by the absence of hæmosiderin. Following operation, the patient's condition was excellent and she left hospital thirteen days after it. During eight days only, she experienced severe pain in the lower intercostal spaces on the left side and twinges in the cardiac region. The pain may be attributed to the Roussel method of anæsthetizing the intercostal and splanchnic nerves. We have noted the same thing in other cases where this method of anæsthesia was employed. The temperature remained within subfebrile limits continuously after operation.

Comparing the data obtained from our findings and supplementary examinations with those shown by the microscopic examination, we may conclude that an infarct or embolus was produced by a factor which cannot be exactly defined. The primary existence of emboli in the smaller splenic vessels explains beyond question the formation of the multilocular cysts. Since the circulation had diminished or disappeared in certain parts of the spleen, areas of necrosis or perforation of softened infarcts had been produced, as mentioned by Chwostowski, for example, with reference to a case of typhoid, and also as mentioned by Stcherbakov in connection with a case of recurrent typhus. As soon as the local blood-supply becomes increased, the spleen becomes momentarily enlarged or symptoms of congestion begin to manifest themselves, and not only may laceration of the pulp occur, but also of the capsule. It goes without saying that traumatism still further facilitates laceration of the splenic pulp, under the given conditions. In our case, a lesion was shown distinctly by the findings, the patient herself perceiving a tumor in the left hypochondrium. In a parallel way, acute phenomena of inflammation occurred, accompanied by chills and high temperature. Phenomena which were clearly peritoneal then ensued, explicable either by infection of the spleen or torsion of its pedicle. The appearance of several cysts evidently increased the size of the mobile spleen and aggravated the various com-

plications which may arise from a spleen of this kind. Increase in the size of the lower extremity mechanically created conditions favoring distention of the ligaments and pedicle and the production of a mobile spleen. The splenic mobility was diagnosticated when operation was decided upon.

Of the supplementary tests, the pneumoperitoneum possibly supplied the most exact picture of the size, form and mobility of the spleen. In our opinion, pneumoperitoneum may prove more useful than any other method of examination in difficult cases. The adrenalin test of Frey is also very important in cases where the spleen has lost its normal contractility because of neoplastic or fibroplastic modifications.

Very characteristically, after ablation of the spleen the menstruation of our patient, previously painful, abundant and prolonged for twelve days at each epoch, became normal after a period of two months and has continued normal thus far. The symptoms cannot be attributed to pressure of the enlarged spleen upon the genital organs, since the abnormal menstruation had existed since the patient's youth. Ablation of the spleen abolished an abnormal condition. Perhaps the writers are correct who recommend irradiation of the spleen with the X-rays in cases of gynecologic hæmorrhage (Nürnberger), for, by lowering the functional capacity of the spleen radiant treatment provides a sort of temporary and partial splenectomy. Subbotic points out in his work a certain correlation existing between the spleen and the menses. He states that, in a case of mobile spleen, malarial splenomegaly was followed by an arrest of menstruation, continuing for two months. After ablation of the spleen, menstruation returned in twenty-four days.

Diagnosis is exceedingly important in cases of splenic cyst, for spontaneous cure cannot be counted upon. Apart from the subjective pain afflicting the patient, as well as from displacement of neighboring organs and symptoms of compression, spontaneous or secondary rupture of the spleen may occur, with hæmorrhage. We believe that splenic cyst may also be followed by splenic abscess, for the presence of a cyst constitutes marked modification of normal conditions and creates a site of lowered resistance.

With respect to complications supervening during operation, we may remark that grave hæmorrhage may occur if existing adhesions are large. Again, the collateral circulation may be considerably greater than the normal circulation and, under these conditions, hæmorrhge may occur when the splen'c pulp is incised or laceration may occur during the intra-abdominal manipulations, and arrest of the ensuing hæmorrhage may be very difficult. Jonnesco therefore advises that, in detaching the spleen from adhesions, incisions be made in the direction of the abdominal walls and not in the direction of the spleen. Among other possible complications may be included opening of the pleura. This is not dangerous, on condition that the diaphragm be immediately sutured. If the cysts are very large, care must be observed that the intra-abdominal pressure be permitted to diminish slowly, in order to avoid sudden irritation of the solar plexus, a result which would prove immediately fatal (Adelmann).

In certain cases, unduly extensive adhesions and the difficulty of orienting the parts may permit diagnostic errors even after opening of the abdominal cavity. In such cases, it is impossible to know whether the cyst arises from the liver, pancreas, kidney, mesentery or spleen. Herfarth thus relates that a cyst supposedly hepatic was recognized in the course of a laparotomy. It was sutured into the wall, and a permanent fistula made, but, after seven months, a fresh laparotomy showed that the cyst was of the spleen, being merely united with the liver by a long tract of adhesions. On learning the real nature of the cyst, the spleen was ablated. Some writers recall the fact that incrustations of calcium salts may be deposited upon cyst walls (Jonnesco).

With respect to the incision employed for splenectomy done in the treatment of cyst of the spleen, any operation of this kind should be performed by means of lateral laparotomy and a para-rectal incision or by means of an oblique or transverse section of the rectus abdominis muscle. Coenen reached the spleen through long, oblique incisions beginning in the left hypochondrium and extending to the vesical region. The patient's position for this purpose was that used for nephrectomy. Mayer removed the spleen from behind, the incision resembling that employed in nephrotomy. In this way he obtained very easy drainage of the secretion toward the back. Others have employed, with the same object, a supplementary incision beginning behind. It may be taken as a general rule that the incision should be sufficiently extensive if the spleen is large and imbedded in adhesions, in order that the entire operative procedure may be in full view. Access to the spleen is thus very important in relation to the abdominal wall. Destruction of the nerve-supply of the wall is followed by formation of a large post-operative hernia. The latter entails a variety of dangers and often obliges the surgeon to proceed to grave and complicated operations. If the spleen is to be approached by the abdominal route, many incisions are available (Ruggi, Kehr, Marion, Sprengl, Lejars, Lecène and Deniker, and Leotta). The incision of Papayoannou, which we mention lastly, especially appeals to us since it respects the nerve-supply of the abdominal wall and gives ready access when the spleen is hypertrophied, permitting adequate view of the entire operation, as we have had occasion to verify during our surgical experience. This incision, in fact, has enabled us to ablate spleens considerably enlarged and accompanied by extensive adhesions.

Since diagnosis is very difficult in certain affections of the spleen, various writers have been for a long time of the opinion that the diagnosis should be based upon material obtained from the spleen. The simplest way of obtaining such material is by means of an exploratory puncture, a procedure recommended by a few writers (Proppuig) but one condemned by most authorities. Although splenic puncture is very dangerous in certain affections of the spleen in which the organ is very tender or in which it may be purulent, and although it is practicable only if operation can be done immediately, it is nevertheless necessary to point out the fact that Rencki has

several times employed splenic puncture to obtain histological and bacteriological data, and without ever encountering unfortunate results or symptoms. For splenic puncture, a hermetically tight Record syringe is required, capable of containing ten grams and provided with a needle one millimetre in diameter. The spleen is immobilized and the patient is requested to suspend respiratory movements. Aspiration is performed very slowly. If necessary, the needle is inserted more deeply. Rencki employs the same needle for introducing one-quarter to one-half milligram of adrenalin and, when the splenic pulp begins to contract, he injects two cubic centimetres of a coagulant as the needle is slowly withdrawn. After applying a bandage and pressure for some time at the site of puncture, an icebag is placed on it for three to four hours, the patient remaining meanwhile at absolute rest. By this method Rencki has diagnosticated Gaucher's disease, among other affections.

Among other methods of surgical diagnosis, exploratory incision must be mentioned, as described by Stubenrauch. He applies local anæsthesia in the axillary line, lays bare the splenic surface by means of an incision eight centimetres long, and performs puncture. In Stubenrauch's case, however, blood continued to ooze after withdrawal of the cannula and the pulp was lacerated afterward. Since suturing failed to arrest the hæmorrhage, the spleen was ablated. This case clearly shows the danger of splenic puncture even when all details of the operation are in full view of the surgeon.

Prognosis should be considered very important in cysts of the spleen, for the cysts may be lacerated or undergo inflammatory changes at any time. Since large splenic cysts elongate the pedicle of the spleen as a general rule, the pedicle may readily undergo torsion and the various consequences of this effect may ensue. If the patient experiences sudden pain, the surgeon must be especially watchful, since the pain may be due to compression or displacement of the organ, to its sudden increase in size, or to laceration of the splenic pulp occurring beneath or with the capsule.

In connection with the formation of cysts of the spleen and the subsequent arrest of its normal function, compensative hypertrophy of the spleen may occur, as reported by Hamilton and Boyer.

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IMPERFORATE ANUS

A METHOD OF DETERMINING THE SURGICAL APPROACH

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Atresia of the anal canal or the lower portion of the rectum occurs about once in every 5,000 births (Tuttle[1]). It would appear to be about equally divided between the sexes. Not infrequently it is associated with other embryologic defects. Structures which have a common development from the urogenital sinus are most likely to exhibit embryologic defects in association with imperforate anus.

Clinical Picture.—Casual inspection of the perineum in the newborn will usually detect the presence of imperforate anus. When the anal opening is normal the recognition of the existence of this anomaly is usually made with subsequent failure of the child to expel meconium. Examination with bougies then will reveal the fact that an interruption of the continuity of the bowel is present. A child with an imperforate anus usually takes his feedings in the usual manner for the first twenty-four hours before regurgitation commences. The abdomen only gradually distends. In those instances where an internal fistulous communication exists with either the bladder, urethra, or vagina the condition may go unrecognized for a longer period of time. When communication exists between the urethra and the rectum, the voided urine will occasionally be tinged with fæcal material; when communication with the bladder exists, constant admixture of fæces with the urine is the rule.

Treatment.—Early establishment of communication with the exterior is necessary in complete atresia of the anal canal or rectum. In the female when communication with the vagina exists, no indication for immediate operative intervention is ordinarily necessary. In such cases the operation may well be deferred until a later period when the transference of the lower bowel between the fibres of the external sphincter of the anal canal can be made with greater safety and more precision. When internal fistulous communication with the urinary passages exists operation is usually necessary to divert the fæcal stream because of danger of urinary infection. That instances of this sort may reach mature age despite the persistence of such an abnormal communication is demonstrated from time to time. In those instances in which a diaphragm-like septum is present, a simple slit of the anal skin and probing of the wound and dilatation with a hæmostat is all that is necessary. Subsequent occasional dilatation with bougies may be required. In those instances where the lower portion of the rectum as well as the anal canal is atresic the operative approach is frequently difficult and uncertain.

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To date no satisfactory method has been devised to determine whether the atresic bowel may be reached from below or not. In the majority of instances the rectum even when atresic does descend well into the pelvis and should be capable of being reached from the perineal approach. Occasionally, however, the rectum remains extra-pelvic and is not accessible from beneath.

Brenner [2] has emphasized the fact that abnormal narrowing of the inter-ischial tuberosity measurement is indicative of the presence of a rectum that may be extra-pelvic. The accompanying figures (1 and 2) [from Keith [3]] indicate the location of atresia in specimens of imperforate anus observed by Sir Arthur Keith in London. pathological museums and hospitals.

In this brief communication we should like to direct attention to a method by which one may accurately ascertain to what level the rectum reaches in
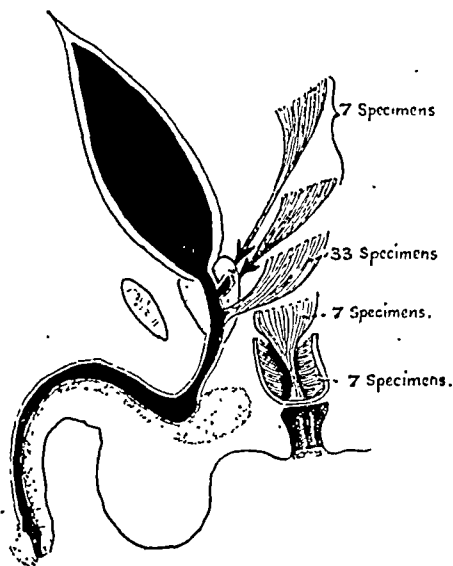

FIG. 1.—The site of atresia in fifty-four specimens of imperforate anus in males examined by Sir Arthur Keith. The specimens in which communication was established with the bladder and urethra are also indicated.
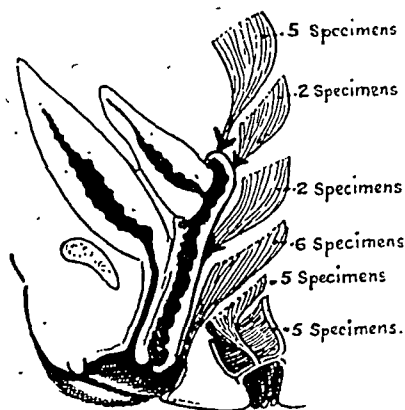
FIG. 2.—The site of atresia in twenty-five specimens of imperforate anus in females examined by Sir Arthur Keith. The specimens in which communication was established with the vagina are also indicated.

the pelvic cavity. If the child is held upside down in the inverted position by the lower extremities the gas in the rectum will rise to the top and indicate the distance intervening between the rectal wall and the skin of the anal dimple when a flat X-ray film is made. We have recently had an opportunity to evaluate the importance of this method in two cases in determining pre-operatively the accessibility of the occluded bowel from the perineum. Even though the rectum is anatomically accessible from beneath in the majority of instances, the corroboration of such definite evidence as the accompanying illustrations afford of the actual level to which the rectum attains lends encouragement and assurance to the surgeon that persistence will reward his efforts when a tedious and seemingly inaccessible approach from beneath prompts him to open the abdomen and perform a colostomy.

The atresic bowel should be approached from the perineum when possible for statistics indicate that the mortality of this procedure is attended with

a risk of about 25 per cent. in which the approach is difficult, whereas when laparotomy and colostomy is done this mortality is more than doubled. When·a communication with the bladder or urethra exists an attempt should be made when a proctoplasty is done to divide and close the abnormal opening. Should such an effort prove unsuccessful a complete deviation of the fæcal current by a colostomy of the permanent type in the left inguinal region may later become necessary to obviate the occurrence of urinary infection.

In those instances in which the rectum is not immediately accessible by

FIG. 3.—Film made of abdomen of Case I in upright position. The gas in the bowel rises in the abdomen.

FIG. 4.—Film made of abdomen of Case I in the inverted posture with imperforate anus. The gaseous outline of the rectum goes practically to the anal dimple and is easily made out. There is also considerable intestinal distention present.

simple puncture through the perineum, dissection should be made as near the sacrum as possible to obviate injury to the urethra.

The external sphincter of the rectum is normally developed in all cases of atresia of the anal canal or rectum. This sphincter develops in connection with the perineum and not with the bowel. Hence, if the proctodæum be present, the surgeon may rely on obtaining an orifice provided with competent sphincters.

A brief summary of the two cases in which the method described above was employed is appended.

CASE I.—Hospital No. 49852. Male child, two days old. Admitted to the University Hospital September 8, 1929, two days after birth. The child was accompanied

by a friendly neighbor who was unable to give any history except that the child had had no bowel movements and had commenced vomiting on the day previous to his admission. As far as could be ascertained both parents were in good health.

Physical examination revealed an otherwise well-developed child apparently in some distress from abdominal distention. The chest and heart are negative; the abdomen is distended and tympanitic; the abdominal muscles are slightly tense, but there is no muscle spasm; the liver and spleen are palpable. No peristaltic waves are visible. Perineum: the diaper was found to be moist with urine but not stained with meconium. The anus was found to be imperforate. There is slight bulging at the anal region and a greenish discoloration at the anal dimple is visible. Physical examination otherwise is negative. Examination of blood and urine is normal. Temperature 97.6°.

X-ray examination with the child inverted reveals the presence of considerable gas

FIG. 5.—Film made of the abdomen of Case II in the inverted posture. The terminal end of the rectum appears to be far removed from the metal disk placed over the anal dimple. There is also considerable intestinal distension present.

FIG. 6.—Plate made also in the inverted posture ten hours later, at which time slight pressure was made over the anal dimple with a clinical thermometer. The feasibility of a surgical approach from beneath is well indicated by this picture.

in the intestinal loops and the rectum is observed to extend as a cone-like projection almost to the skin margin.

The patient was operated upon immediately after the X-rays were made. The anal dimple was probed without anæsthesia and greenish meconium came away; with the aid of a small Halsted hæmostat the opening was dilated by spreading the forceps. The post-operative convalescence was very satisfactory and the child was discharged in good health on September 11, 1929.

CASE II.—Hospital No. 50121. Male child, admitted September 29, 1929, fourteen hours after his birth at Osakis, Minnesota. The imperforate anus was discovered at birth by the family physician (Dr. A. J. Gullickson). The child was in very good condition and had not vomited. The mother and father were normal and in good health. Physical examination revealed an otherwise apparently well-developed child. No abnormal findings in chest and heart are made out. The abdomen is not distended and peristaltic waves are not visible. Liver and spleen are not palpable. The diaper is moist with urine but not stained with meconium. No bowel is palpated through the

perineum by pressure upon the abdomen. There is no discoloration at the anal site. Examination is otherwise negative. Blood and urine are essentially normal.

X-ray examination with the child in the inverted position shows intestinal distension not appreciable on visual inspection of the abdomen; the distal loop of bowel filled with gas extends to just below the pelvic brim. At an examination made ten hours later the anal dimple was gently pressed upon with a clinical thermometer which demonstrated that the rectum could be reached from below. The patient was operated upon twenty-eight hours after birth and the rectum brought down and sutured to the skin margins. Some difficulty was encountered in finding the lower end of the atresic bowel.

The post-operative convalescence was very satisfactory until the sixth post-operative day (October 7, 1929). The child then developed attacks of dyspnœa and cyanosis. X-ray examination of the chest showed beginning pneumonia. On October 9, the patient again became very dyspnœic and cyanotic. Oxygen was given but the patient died at 9:55 A.M.

Post-mortem examination revealed an extensive bilateral pneumonia, an atresia of the aorta, a patent foramen ovale and a patent interventricular septum. There were no other abnormalities of the gastro-intestinal or genito-urinary tract. The patient had made a satisfactory convalescence and death from pneumonia and congenital heart defects was unrelated to the operation.

CONCLUSION

The employment of the flat X-ray film of the abdomen with the infant held in the inverted posture serves as a reliable method of determining the surgical approach in imperforate anus.

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PRIMARY CLOSURE IN PROSTATECTOMY

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Adequate drainage with secondary healing of prostatectomy wounds, as opposed to primary closure and healing, is a surgical tradition which so thoroughly dominates the modern surgeon's mind that any departure therefrom is apt to be regarded as rank heresy. This ancient teaching rests primarily on the very estimable fact that in the past no more adequate control of hæmorrhage was known than the use of gauze packs or rubber bags to exert pressure against the bleeding surfaces. Drainage and secondary healing were therefore necessary corollaries. Moreover, as most prostatectomy wounds were apt to be more or less infected, drainage and secondary healing were considered a necessary evil in conformity with the old fetish which taught that surgical wounds involving the urinary tract must of necessity drain urine for a while before healing. In other words, a temporary urinary fistula must of necessity be the price of any incision involving the urinary tract.

It is my purpose to demonstrate in this presentation without being iconoclastic and without offending the fundamental principles of sound surgery, that primary closure and healing are applicable at least to perineal prostatectomy wounds, and can be made the rule rather than the exception.

It is aside from the main theme to discuss in this paper the relative merits of suprapubic *versus* perineal prostatectomy. The reader is referred to Hinman's recent comprehensive treatise [1] on perineal prostatectomy. Having been trained in the latter procedure, it has my personal preference in the vast majority of cases. The perineal operation is probably a more benign operation, a conclusion which is supported by the recent work of Goldstein and Abeshouse.[2] However, the suprapubic operation is in more general favor because it is technically easier for the self-made urologist, and probably the ultimate results are not radically different in either method. The only opportunity for the perineal operation to gain more general favor is by the production of results noticeably superior to those which can be obtained by the suprapubic approach. This it has a chance to do because of the relatively greater adaptability of primary closure to the perineal operation.

Both the suprapubic and perineal operations of prostatectomy have become fairly well standardized, yet they share one fault in common, and that is our present crude methods of dealing with hæmorrhage at the time of operation. As a former assistant to Dr. Frank Hinman, it used to be my painful duty to remove the packs after twenty-four hours in the days when he was routinely packing all his perineal cases. The conclusion was finally reached that whether one uses gauze packs or distensible rubber bags they both offer the following objections:

1. They stretch open still farther the dilated prostatic cavity, which under

ideal conditions should be permitted to collapse and shrink as soon as the gland is removed.

2. They cause the patient discomfort, not only by their presence but by their removal as well. Patients who have been prostatectomized look upon this as the most unpleasant feature of the treatment of prostatic obstruction.

3. They delay wound healing by leaving behind them a temporary urinary fistula on their withdrawal, which requires ordinarily from two to four weeks to close, and sometimes even longer.

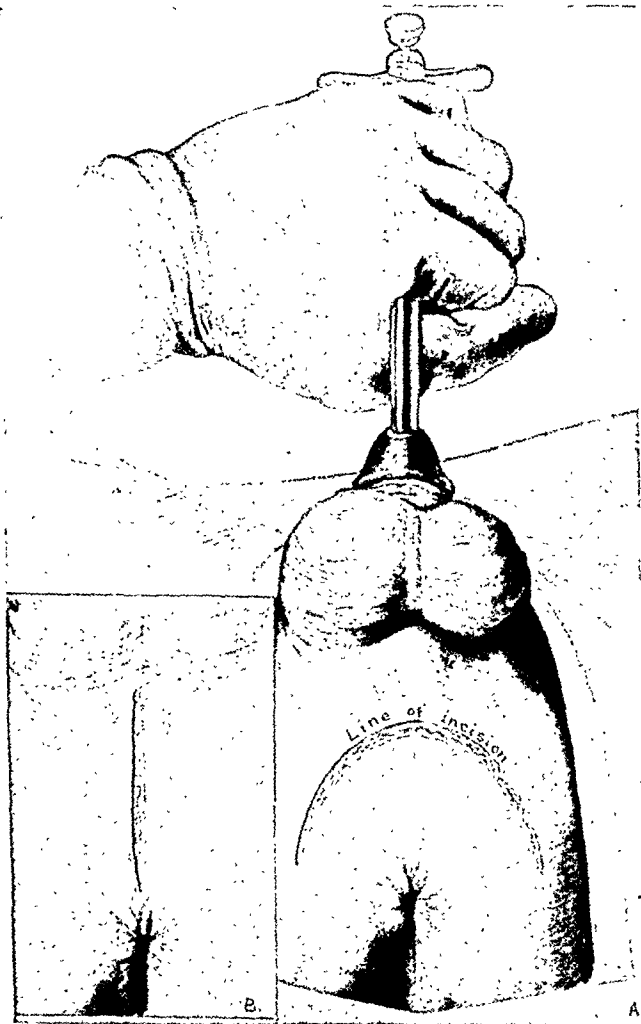Packing is not an ideal way of controlling hæmorrhage in any operation,

FIG. 1.—Drawing illustrating types of incisions used in perineal prostatectomy. The transverse semilunar incision (A) is most suitable for the operation here described. Note the Crowell tractor which has been passed through the urethra into the bladder.

FIG. 2.—The second step in the operation, following the primary incision through the skin, is here illustrated, namely, the penetration of ischio-rectal fossæ on either side of the central tendon posterior to the transversus perineal superficialis muscles. The point of penetration is on a line joining the ischial tuberosities. The index finger enters easily by blunt dissection until the apex and posterior surface of the prostate is felt.

and least of all in prostatectomy where urinary drainage acts as a deterrent to wound healing. In general surgical operations packing is always a last resort when other methods fail to control hæmorrhage, and this should be true in prostatectomy also.

This line of reasoning seemed more theoretical than practical to me at first, as perhaps my original publication [3] may have seemed to some who may have read it. I judge that in general the reaction to this idea has been much as my own reaction was to the paper by Lower,[4] in which he advocated

primary closure in suprapubic prostatectomy. In the discussions which followed, his procedure was rather severely criticized by Chute, Bransford-Lewis, Randall and others. I shall not enter into the reasons against primary closure in suprapubic prostatectomy, but those surgeons to whom they are not obvious will find them well enumerated in Randall's discussion of Lower's
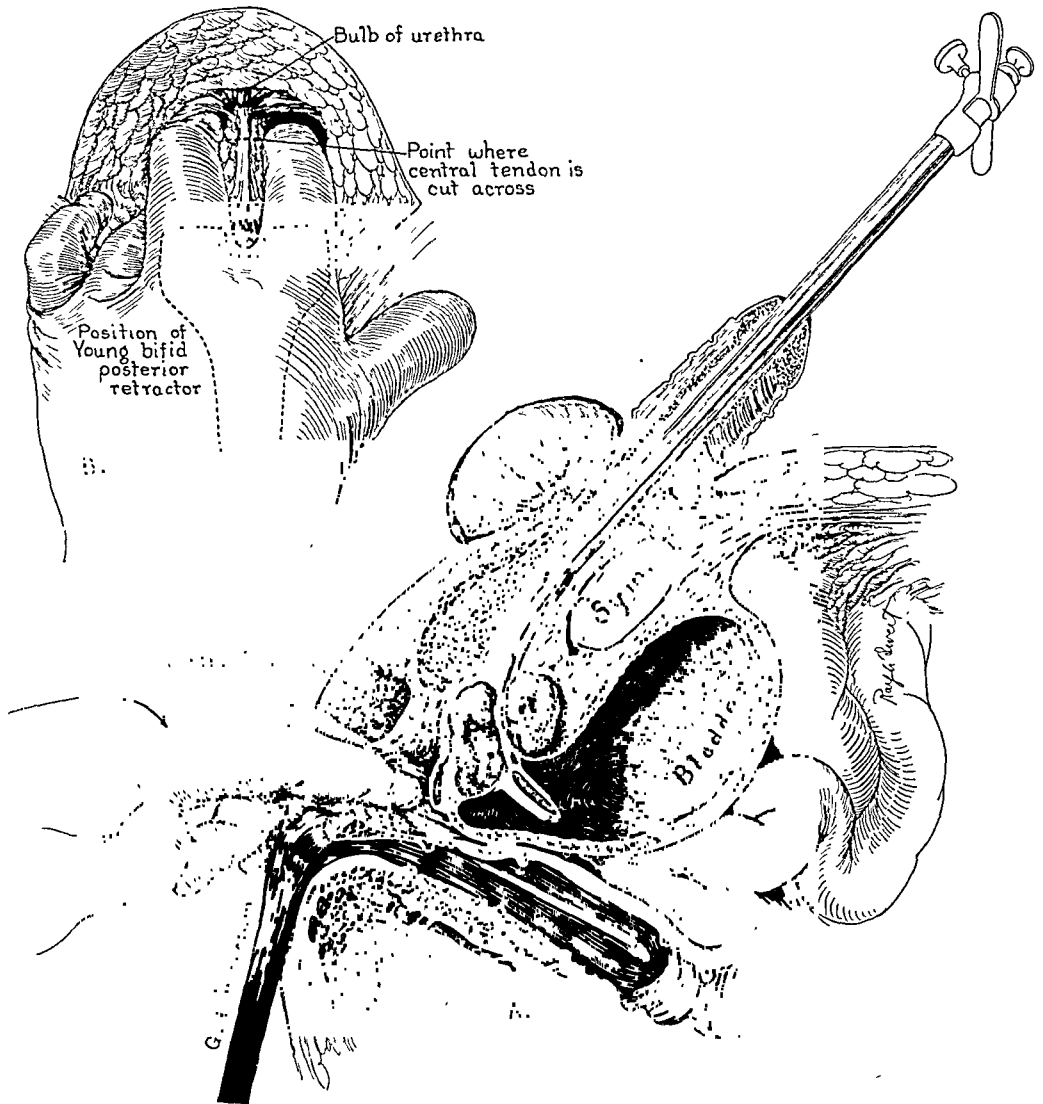

FIG. 3.—The third step in the operation is the division of the central tendon back of the bulb and transversus muscles (B). During this procedure the rectum is retracted posteriorly with either the Young bifid retractor or two fingers of the left hand. (A) is a lateral view of the perineal structures and their relations. The central tendon has been placed under tension preparatory to its division. Note the Crowell tractor passing through the urethra into the bladder with its blades opened and forcing the prostate down toward the wound, the symphysis pubis acting as a fulcrum. Note, also, the instrument in the rectum serving as a constant guide to its location.

paper.* In the perineum, however, conditions are entirely different and the arguments against primary closure do not hold here. Before primary closure can be safely done, one must first be certain that all bleeding has been care-

* Recently S. H. Harris in an article entitled "Suprapubic Prostatectomy with Closure" (Surg., Gyn. and Obs., vol. 1, January, 1930, pp. 251-260) reported in detail a method of primary closure in suprapubic cases which has proved very successful in his line.

fully controlled. My procedure has been to swab out the prostatic cavity with warm 10 per cent Monsell's Solution or a mixture of one dram of tannic acid to an ounce of adrenalin, and then, if necessary, apply mattress sutures approximating the lip of vesical mucosa around the bladder neck to the prostatic capsule. This not only checks bleeding around the bladder neck where post-operative hæmorrhage is most apt to occur, but also obliterates the prostatic cavity. Doctor Young depends on sutures entirely. If bleeding can be satisfactorily controlled in this manner the wound is closed tight with-
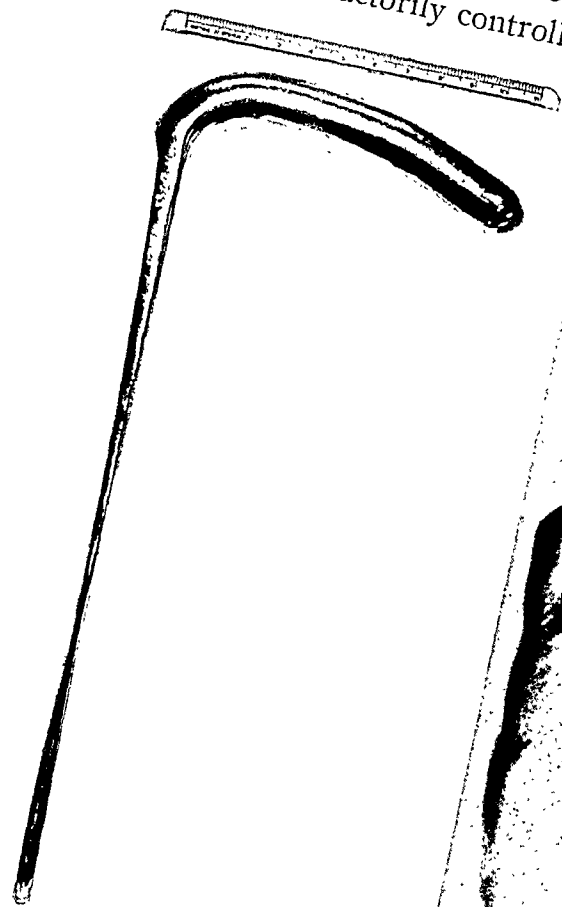

FIG. 4.—Photograph of the rectal guide. This may be inserted in the rectum at the beginning of the operation or at any subsequent stage should there be doubt as to the exact position of the rectum. Such a device is positive insurance against rectal injury, which is the main bug-bear of the perineal operation.

Bulb retractor

M. transversus perinæ superficialis

urethralis
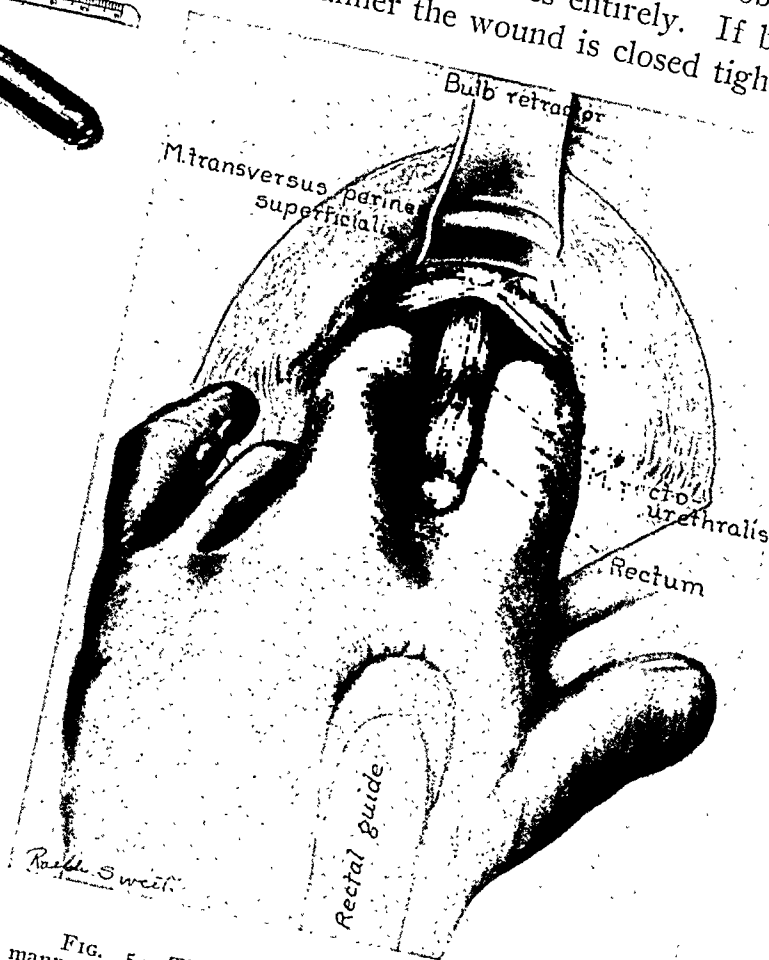
Rectum

Rectal guide

Ruhl Swart

FIG. 5.—The crucial step in the operation is the manner of dealing with the recto-urethralis muscle follow-ing division of the central tendon. This muscle is not a definitely demarcated structure, but represents merely cer-tain fibres of the longitudinal muscle layer of the rectum which insert in the region of the apex of the prostate and hold the rectum in close apposition to the posterior aspect. In the illustration a dotted line shows where the recto-urethralis is split near its insertion while two fingers of the left hand hold the rectum down out of harm's way. The recto-urethralis is placed on tension by retracting the urethral bulb anteriorly. In some cases it is easier at this stage to approach the prostate laterally, pushing the recto-urethralis muscle to one side.

out drainage, the urinary stream being taken care of by means of a retention catheter through the urethra, attached to a Connell suction apparatus.

If bleeding cannot be checked satisfactorily by suture then the prostatic fossa is packed with gauze strips (see illustrations). In general, it is easier to take sutures in the bladder neck after perineal prostatectomy than one might at first think. Doctor Young uses a boomerang needle for this pur-pose. To facilitate this step in the operation in difficult cases I have had a

special suture carrier constructed (Fig. 10), but ordinary needles and needle-holders are usually applicable.

In perineal prostatectomy it is generally possible to get an adequate view of the bladder neck, and I venture to say that with a little practice one can close the majority of cases without using either packs or bags. This should not lengthen the operating time more than five or ten minutes at most. In a consecutive series of 20 perineal prostatectomies (see Table I) I have been able to do a primary closure successfully in 13. In the other 7 I felt compelled to resort to packs to completely check the bleeding, thus making primary closure and primary healing impossible. Analyzing the two groups
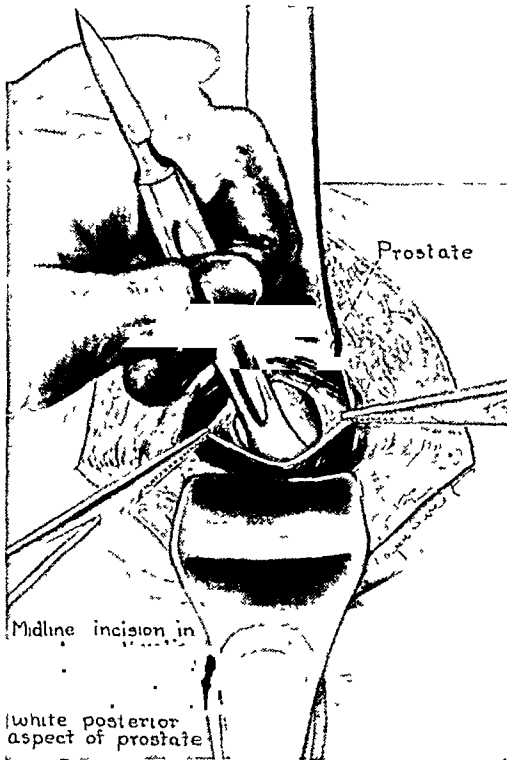

FIG. 6   FIG. 7

FIG 6.—The margins of the mid-line slit in the recto urethralis are grasped with Allis forceps and a knife handle slipped down over the posterior surface of the prostate between the layers of Denonvillier's fascia, which covers the posterior aspect of the prostate gland. The smooth, glistening, greyish-white surface of the prostate is now visible.
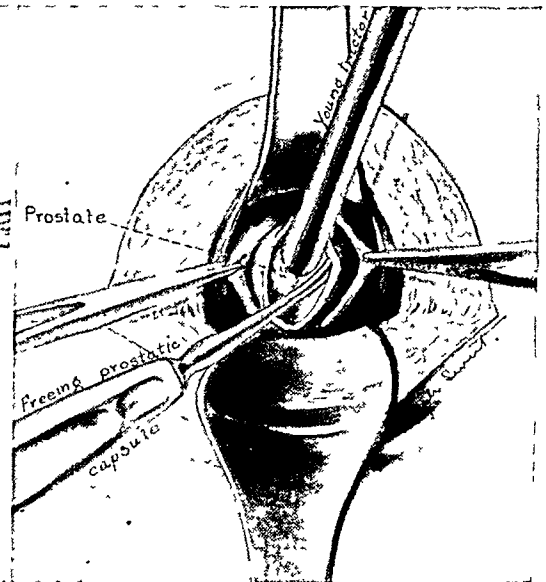
FIG. 7.—A mid-line incision is made in the prostate onto the instrument in the urethra. This incision is extended toward the base of the prostate and does not approach too closely the apex where lies the external vesical sphincter. The plane of cleavage between capsule and prostate is now revealed and enucleation is begun with the Kocher dissector. If it is considered expedient the Crowell tractor is removed and replaced by the short Young prostatic tractor, which is passed through the wound into the bladder and its blades opened so as to aid in the enucleation by bringing the prostate into the wound.

of cases with respect to duration of post-operative convalescence, the average time sent in the hospital by those in whom packs were used was twenty-two days. In the cases of primary closure in which packs were not used the average time spent in the hospital after operation was sixteen days. This figure would be even smaller were it not for the fact that 3 cases developed epididymitis, and in 2 the primary closure broke down and drained temporarily. One patient went home on the eleventh day post-operative, while

a number were discharged by the fourteenth day. Although this is a small series to report, I have been able to show to my own satisfaction with a more extended experience that this method will save patients on an average of a week or more in the hospital, not to mention the saving of dressings and of personal discomfort to patients occasioned by the removing of packs or bags after operation. The perineum is notoriously resistant to infection but even so, the remarkable lack of local or general reaction, and redness or swelling in the wound has exceeded my fondest expectations.
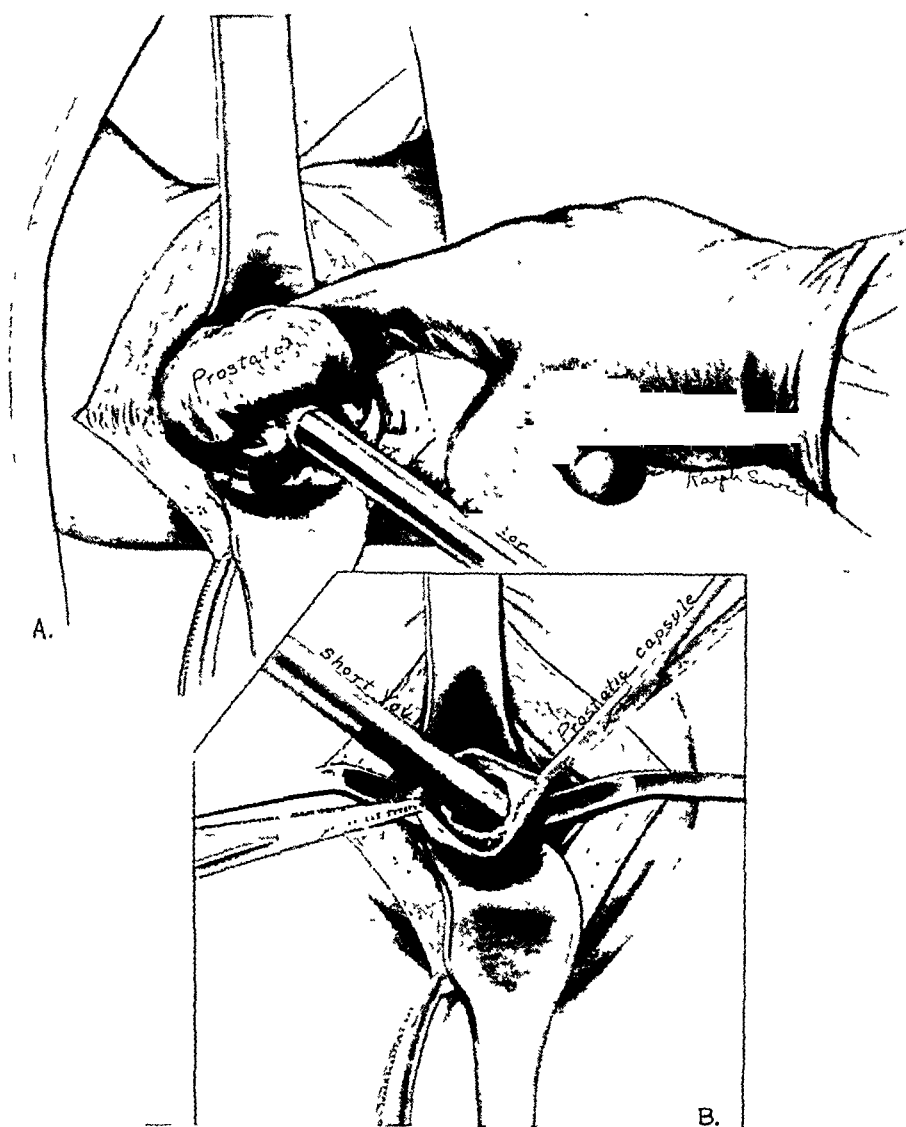
Fig. 8.—Completion of the enucleation of the prostate (A). The prostate is shelled out either en masse or piecemeal with the index finger sometimes aided by curved scissors, care being taken not to tear the incision in the prostatic capsule. Following enucleation the prostatic fossa can be visualized (B) and measures instituted to control bleeding as outlined in the text.

I felt at the time of publication of my original article on primary closure that I was responsible for an innovation which marked a distinct advance in the field of prostatic surgery. Later I found that I must share priority with Dr. Hugh Young, of Baltimore, since he had published in the same year (1928) in *Nelson's Loose Leaf Living Surgery* a method which he called "Complete Plastic Closure of the Prostatic Wound" which was identical in almost every detail with my own procedure. Doctor Young stated that he

had carried out primary closure in about 100 cases. He stated further that the results were very satisfactory, and in 60 per cent of the cases there has been no leakage through the perineum and apparently *per primam* healing of the capsular closure. He further stated that time alone will tell whether plastic closure with catheter drainage through the urethra is as safe an operation as free perineal drainage. His conclusion was that it gave a speedier convalescence. This procedure is probably not applicable to all
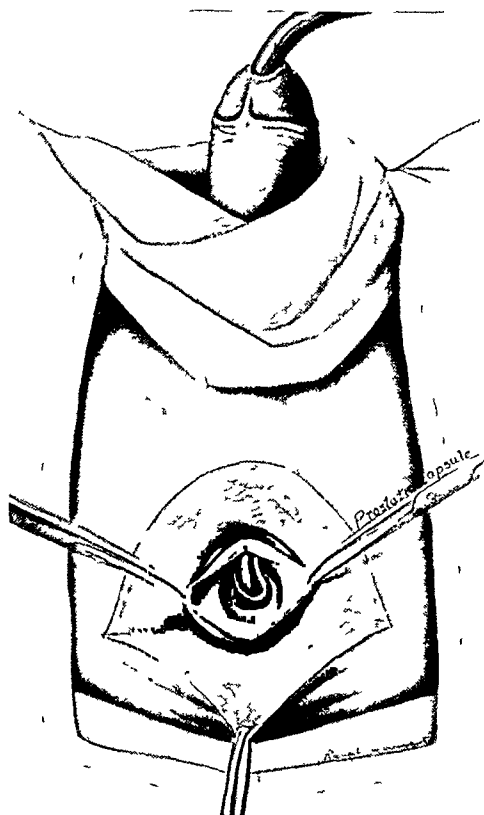
FIG 9 —Drawing showing catheter (2 hole Eynaid 26 F) passed through urethra to bladder, prior to closure of prostatic capsule, for permanent drainage
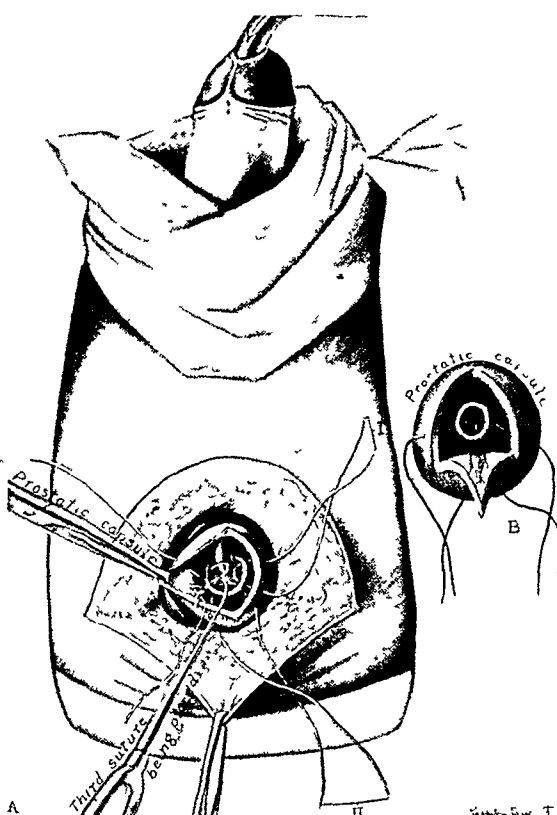
FIG 10 —Drawing to illustrate methods of sutur ing bladder neck and prostatic capsule to control bleeding and obliterate prostatic fossa, (A) in case the mid line incision is made through the prostatic capsule, (B) in case the inverted V type incision is used Variations are made in these sutures to suit the individual case

TABLE I

Primary Closure	Time in Hospital Post-operative	Complications
—	21 days	
—	14 days	
✕	14 days	
—	21 days	
✕	12 days	
—	25 days	
✕	21 days	Epididymitis
—	26 days	
✕	14 days	
✕	28 days	Epididymitis

Primary Closure

TABLE I—*Continued*

Time in Hospital Post-Operative	Complications
24 days	
13 days	Epididymitis
14 days	Wound opened
13 days	
14 days	Cancer
Died*	
20 days	
22 days	Wound opened
11 days	
26 days	Epididymitis

XXXXXX
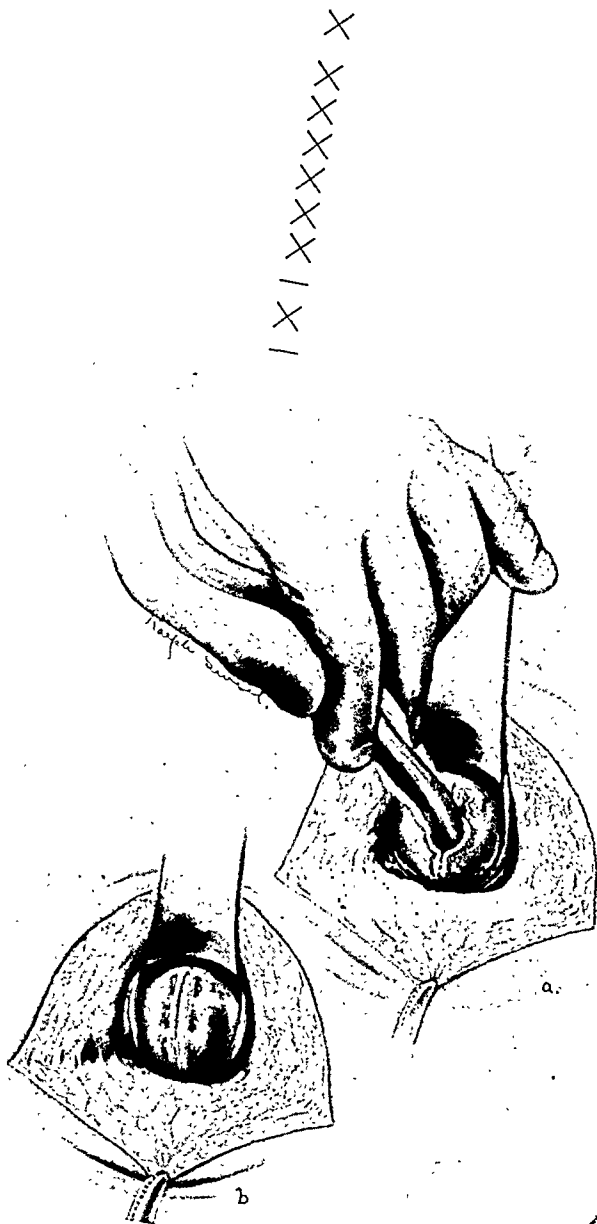
Fig. 11.—In some cases sutures including the lip of mucosa at the bladder neck are not necessary so that the prostatic capsule is closed with mattress sutures of No. 2 chromicized gut as in (b). In cases where packing must be resorted to, a catheter is passed through the urethra (Fig. 12) and a gauze strip is packed in the prostatic fossa around them (a). A retroprostatic pack may also be used if necessary.

Fig. 12.—Drainage is provided via the natural channel by means of a F. 26 catheter passed through the urethra into the bladder. A second catheter through the wound to the bladder is used only in those cases where it is necessary to resort to packing to control hæmorrhage.

Twenty Cases. Packs used in 7. Average stay in hospital, 22 days post-operative. Primary closure 13. Average stay in hospital, 16 days post-operative. Two of 13 cases of primary closure opened and drained.

* This patient on hospital entry had complete retention of urine and was in uræmia, with blood urea 237·5 milligrams per 100 cubic centimetre and creatinine 7·5 milligrams per 100 cubic centimetre. Phthalein output for two hours—o. After two months on retention catheter, etc., blood chemistry was normal, but he still constituted a practically hopeless surgical risk.

Approximation of levator ani muscles by mattress sutures

Fig 14—The final step in primary closure without drainage consists in approximating the retroprostatic tissues and levator ani muscles with mattress sutures of No 2 Chromic (a) and the skin edges with a running subcuticular suture of No 2 Chromic (b) (The skin flap is held by Allis forceps applied to the subcutaneous fat and not by a hemostat on the skin as shown by the artist)

Approximation of levator ani muscles by mattress sutures

Fig 13—Completion of wound closure, consisting in approximation of perineal musculature with mattress sutures of No 2 chromicized gut When bleeding has been controlled without the use of gauze packing the perineal catheter is also dispensed with, and the perineal wound closed tight without drainage of any sort All drainage is then via the retention catheter in the urethra, which is removed usually within six to nine days after operation Perineal packing and catheter when used are removed in forty eight hours

cases, but the results justify its use in every case in which it can be easily and quickly accomplished. Certainly, no one is entitled to pessimism with respect to this procedure without the justification of personal experience.

The accompanying figures illustrate the steps in the operative procedure so clearly as to obviate the necessity of written description.

CONCLUSION

It has been shown that primary closure and primary healing of perineal prostatectomy wounds can be successfully accomplished in a fair percentage of cases, contributing to the greater comfort of the patient after operation and shortening convalescence.

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HEREDITARY DEFORMING CHONDRODYSPLASIA OR MULTIPLE EXOSTOSES

REPORT OF A FATHER AND TWO DAUGHTERS SHOWING SIMILAR MULTIPLE SYMMETRICAL EXOSTOSES AND FIFTY OTHER CASES COLLECTED FROM THE ENGLISH LITERATURE SINCE 1917.

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OF WILMINGTON, OHIO

THE above title of this most interesting condition is quite descriptive and was given first by Virchow, Ehrenfried [17] reports, although Mr. Cæsar Hawkins in 1837 was among the first to describe it under the name of *laminated exostoses*.[6] Some of the earlier writers state that these bony growths have been known for a long time.

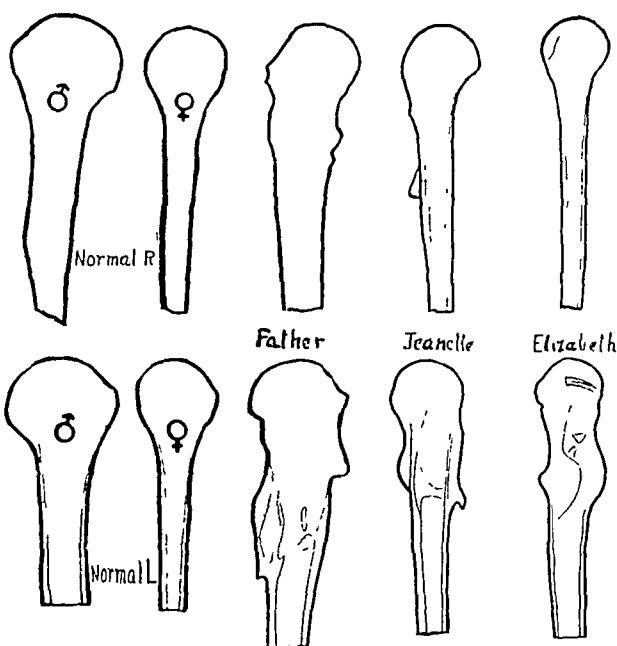An unknown disturbance of the physiology of the diaphyseal side of the epiphyseal cartilage results in a more or less symmetrical outgrowth of bony or cartilaginous tumors in or on the long bones situated at the diaphyseal ends mostly and also on the shaft. They are located mostly on the ends of the bones that have the greatest amount of diaphyseal growth and strange to say, these are the regions that are most frequently fractured during the first two decades of life. This point will be elaborated later in this paper.

These tumors are usually benign and a majority of cases are hereditary. Certain deformities are common due to the size of the tumors and abnormal development of the bones.

FIG. 1.—Proximal ends of right and left humeri. Left side more involved than right. Strikingly similar development grading from eldest to youngest patient. Similar gradation on the right side.

Ehrenfried [17] in 1915 reviewed the foreign literature carefully and in 1917 [19] the American literature representing some 600 cases in over 300 papers in the first and about seventy-three in the second. From 1917 on I have been able to add fifty cases reported in the English literature in addition to my own three.

I shall summarize the known facts and possibly inject a new idea into this subject. The facts recorded in the literature have been the result of keen observation by persons of renown who have left little new to report.

Terminology.—A multitude of terms proposed are listed in the articles of Ehrenfried,[17] Campbell [30] and Christian.[39] However the term adopted in this paper is considered satisfactory and self-explanatory.

Occurrence and Distribution.—The occurrence of this disease seems to depend directly upon the interest shown in it. According to Ehrenfried, since 1890, 60 per cent. were Germans, 27 per cent. French, 8 per cent. English, and other nationalities made up 5 per cent. Surgeons who have become interested in this disease in England and America have each discovered a number of cases in a comparatively short length of time.

Since the X-ray has caused us to lose the art of skeletal palpation, most cases thereby are not discovered. One of my patients had his leg amputated and the tumors were not discovered until thirty years after this and then only through their discovery in a daughter.

Further study may show that the condition occurs more frequently in countries that suffer the greatest amount of skeletal trauma.

From Russia, Italy, Japan, Denmark, Holland, Norway, Roumania, Bulgaria, Scotland, Ireland, Galicia, Sweden, Switzerland, Egypt, Argentina and India cases are reported, also two cases from New Zealand by White.[27]

Many cases have been discovered by a careful study of other members of the family.

There may be great significance in the sex ratio as will be shown later. While the studies show different results, still the males greatly predominate. In 163 cases the ratio was 3 to 1, Reinecke;[17] 236 cases, 5 to 2, Ehrenfried;[17] twenty-nine cases, 3 to 2, Dwyer.[24] Lewin [34] says that this ratio of 3 to 1 is probably due to the increased risk of trauma in the male. Since 1917 the author in forty-five cases found a ratio of 3 to 1.

Meyerding [33] reported 265 exostoses in 232 patients; 150 males, eighty-two females. Most of the patients were of the laboring class; but no sure cases of hereditary chondrodysplasia were recorded. However the sites and order of occurrence are the same as in chondrodysplasia namely, femur, tibia, humerus, foot, fibula, scapula, ilium, supermaxilla, clavicle, mandible, radius, fingers, ulna, etc. This is similar to the distribution of sarcoma in the long bones, he says.

Percy [15] found in a family of 113, thirty affected with a ratio of five males to one female. In a given family in two generations were found twenty-one affected; another family in two generations had twelve affected and in two other families in three generations there were fifteen affected in each.

Few negroes are affected and in America, Anglo-Americans predominate.

Heredity.—While this disease is looked upon by all writers as a true hereditary affection because most cases give such a history, I believe more data should be presented in reporting cases in order to rest this assumption upon a firmer foundation. My observations were made upon three cases, a father and two daughters, a daughter and son being unaffected, which facts
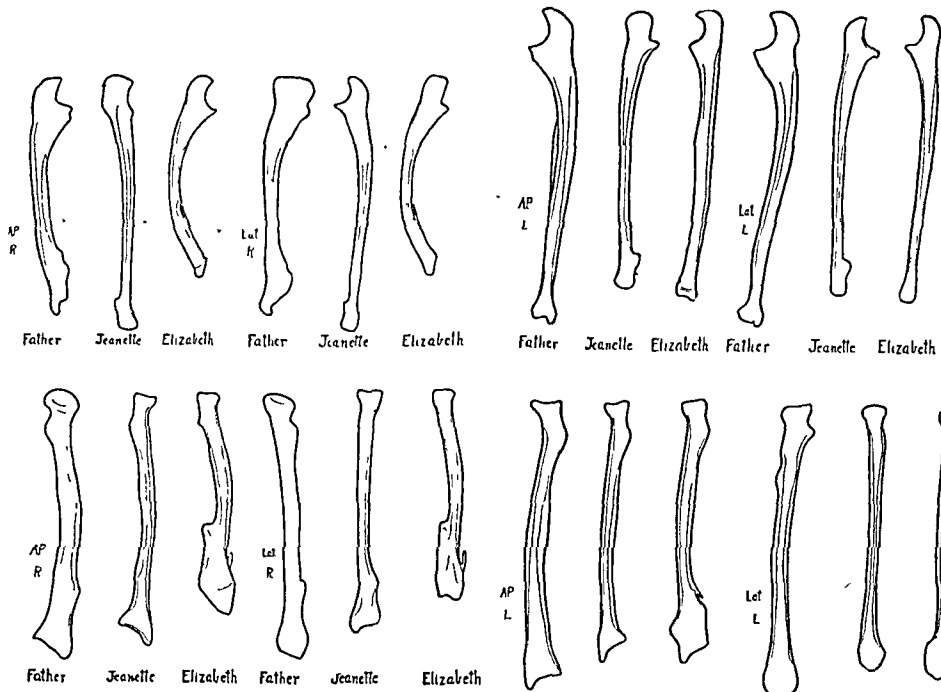
FIG. 2.—Right radii and humeri. The youngest patient shows greatest involvement. The father has the least involvement of the radius while Jeanette has least involvement of the ulna.

FIG. 3.—Left radii and humeri. The bones of both Jeanette and Elizabeth are of equal length but shorter than the father's. There is greater enlargement of Elizabeth's radius than Jeanette's. The reverse is true of Jeanette's ulna.

FIG. 4.—There is strikingly similar exostoses and development at the neck gradating from father to Elizabeth, the youngest. The right side shows less tendency to exostosis but abnormal development is present.

I believe will conclusively prove the hereditary idea as far as they are concerned.

At the request of Dr. Walter Simpson I presented these three cases before the Dayton Pathological Society in the winter of 1929. Doctor Simpson expressed the opinion that the facts given proved unquestionably that we were de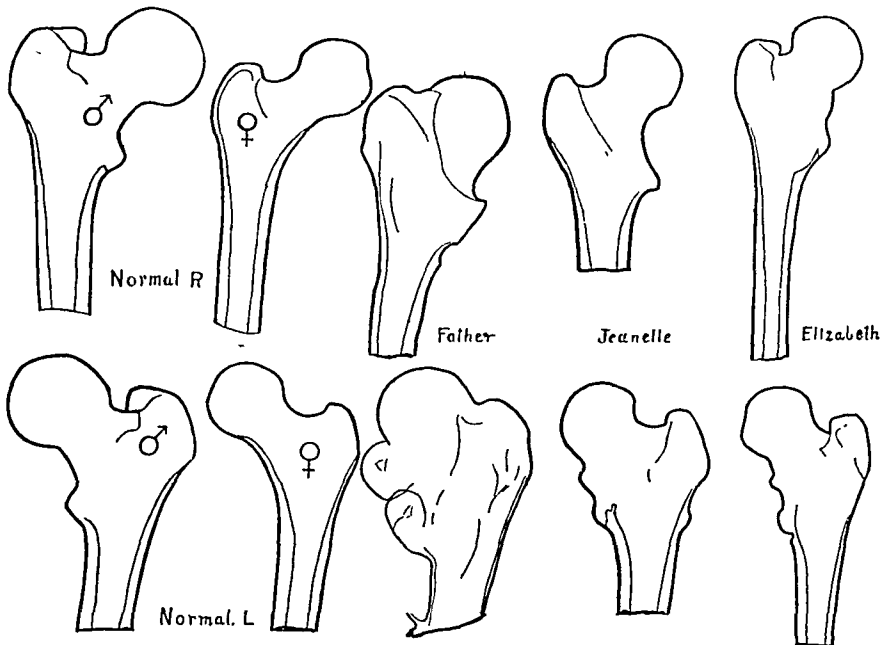aling with a hereditary disease. The fifty cases reported since 1917 show a big hereditary influence. Ehrenfried [17] says that it is now generally accepted that heredity plays the most important if not the only rôle in its occurrence. The condition has been transmitted by unaffected mothers and affected mothers have had affected children by different husbands. One father had affected children in two marriages, Gorsline.[22] Rarely
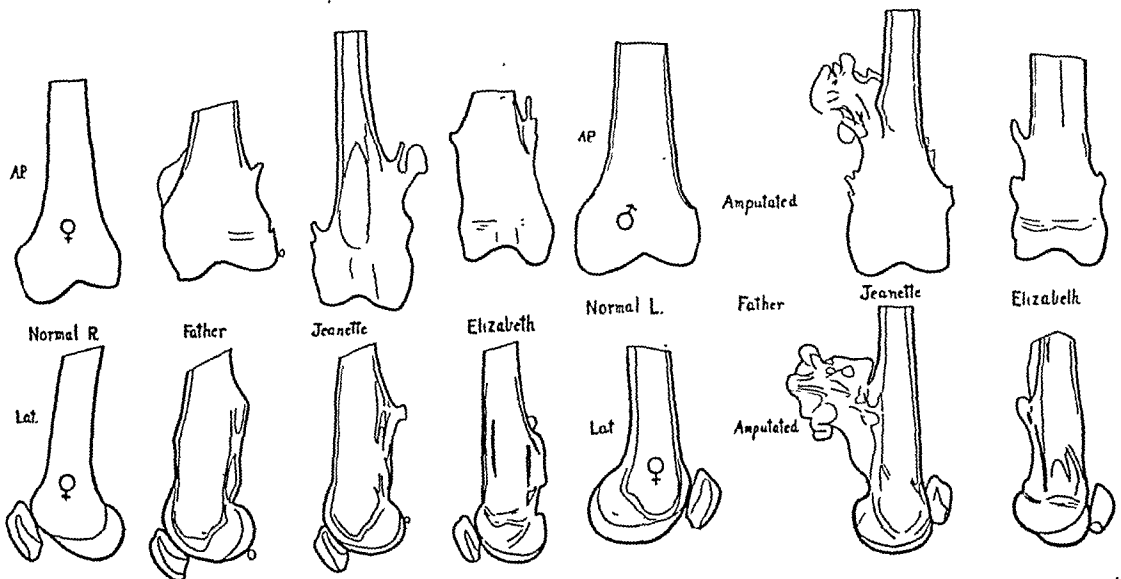

FIG. 5.—Lower end of right femurs. The development is quite similar in all three cases. Lateral view shows a striking developmental gradient.

FIG. 6.—Lower end of left femurs. Father's femur amputated thirty years ago for so-called giant-cell sarcoma evidently a giant-cell tumor. Jeanette has quite a large cauliflower exostosis. Elizabeth shows slight tendency to the same development.

it skips a generation in affected families. Males transmit the disease more often than females.

The sex ratio of three males to one female, etc., would seem to indicate that in man germ cells are male and female from the start, that is sex-determined. It remains to be proven that an unaffected male can transmit the disease. I see no reason why it is not possible. Dwyer [24] corroborates Ehrenfried's observation on this point.

Keith [23] says that the disorder is Mendelian in its incidence while Oberndorf [10] in 1910 asserts that even those who insist most urgently upon the hereditary nature have been unable to establish any definite sequence or order in the matter of inheritance.

In cases where there is a negative family history we should not assume that heredity plays no part as many patients are wholly unaware of the presence of the affection as was the case in two of my patients. I believe that it is very important in these so-called non-hereditary cases for the doctor himself to undertake an investigation of the family if possible. The work

of Percy [15] has shown what is possible from such a study; thirty affected in four generations with a ratio of five males to one female. They were descended from a male. Ord [29] presents a genealogical tree in which an affected female transmitted the affection to three males and one female.

An accurate comparison of the tumors of identical bones from affected members of a family, individual and collective measurements of the long bones, will shed important light upon the problem of heredity. Outline drawings made from bony shadows on X-ray films are an ideal way to study this problem. Such a study of my cases shows clearly that nature is striving to strike a balance in the total lengths of identical bones, also as to the size of identically situated tumors.

In some respects the shunting of these germ plasm impressions in the
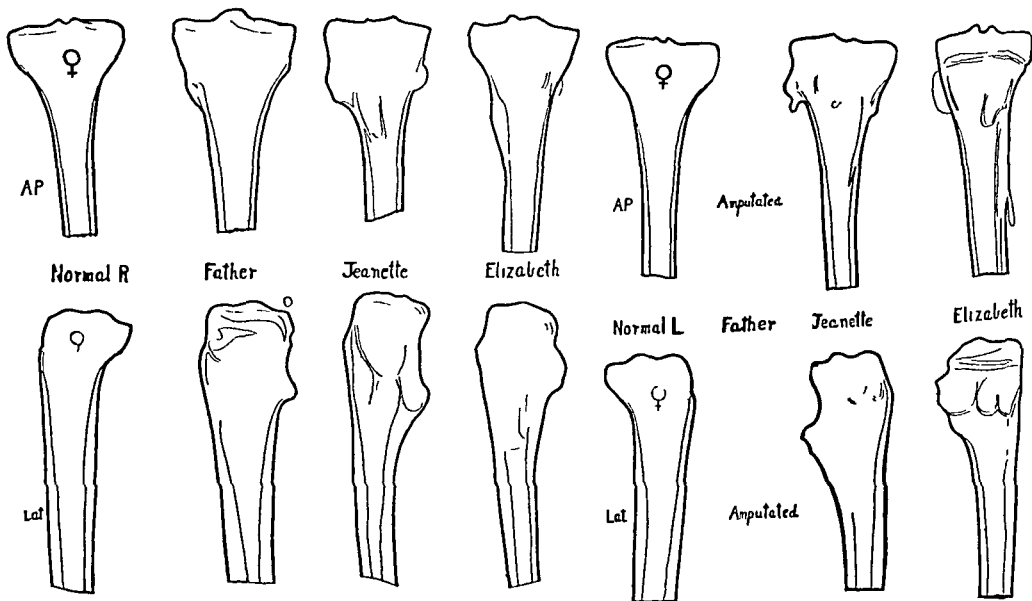
FIG. 7.—Upper end of the right tibiæ. Shows equal abnormal development.

FIG 8.—Upper end of left tibiæ. Father's tibia has been amputated and small exostoses of the daughter's bones are much the same.

different germ cells resemble the marvelous recording of associated ideas in our minds.

Supernumerary fingers, microdactylia and angioma are some congenital affections that may accompany this affection. They too are transmissable.

Pathology.—The X-ray has supplied most of our knowledge of the pathology of this disease. Enough tumors have been removed surgically to give us a very good idea of the gross and minute changes and two or three surgeons have been curious enough to remove a wedge of tissue across the epiphyseal line. It shows an irregular arrangement of the cartilage cells making up the intermediary cartilage. This cartilage, all are agreed now, is the seat of the trouble, the cells of which on the metaphyseal side being primordial or anlagal in character are responsible for products of their abnormal development. Cartilage proliferation and ossification are abnormal as shown by Ash at Harvard from a study of a piece removed by Ehrenfried.

Growth of cartilage seems to be excessive and calcification is extremely irregular. The diaphyseal end of the bones may be filled with masses of
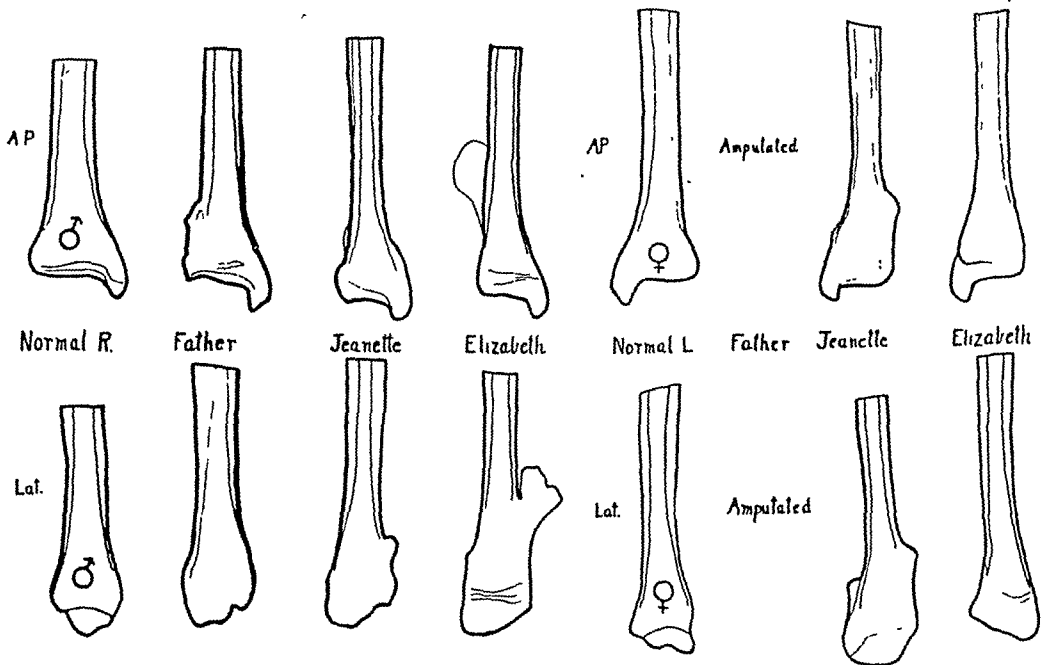
FIG. 9.—Lower ends of both tibiæ. On the right side the developmental gradient is in reverse to age. On the left side, the father's tibia is amputated but it would probably have shown a greater involvement than the two daughters. Nature seems to be striving to establish a normal development.

cartilage cells arranged often in parallel or irregular manner with their bony partitions producing the longitudinal striations. There may be some inter-
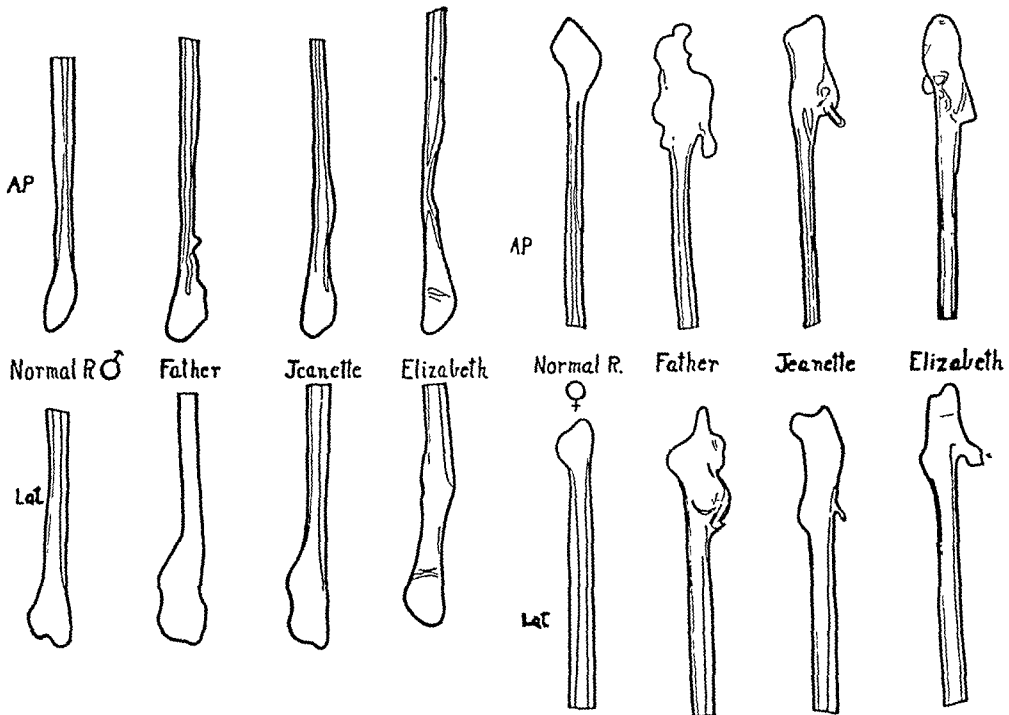
FIG. 10.—Lower and upper ends of right fibulæ. Shows a similar and equal abnormal development. Note the spurs on the upper end.

mingling of marrow. Under the microscope, Ehrenfried states that it looks not unlike chondroma. The bone cortex is thinned out and irregular cartilage gives the impression or appearance of cysts.

7

While the epiphysis seems to escape tumor formation, it is small or misshaped. Premature ossification of the mediary disc may occur in addition to being oblique, irregular, narrow or zigzag in shape.

KEITH,[25] an anatomist, has approached the subject in the right direction, I believe. He considers it a disorder of growth and not in the category of tumors. Nature, he claims, falls short in the normal modeling of bones, a process first studied by John Hunter. A diagram of this process illustrates this article. The former state he calls diaphyseal aclasis, suggested to him by Mr. Morley Roberts.

The cartilaginous exostoses or chondromas no doubt are due to this aclastic state whereby nests of cartilage cells uncalcified are left at first scattered in or under the thickened hyperactive periosteum and the end-result of their natural history is exostoses that may vary in size from that of a pea to many centimetres in diameter.

PERCY[15] removed an exostosis from the right humerus 13.5 centimetres by 12.5 centimetres by 11 centimetres. They do not possess unlimited growth or infiltrate. Typical cases resemble a cauliflower growth and have either a broad or a narrow pedicle. Meyerding[32] says that the history may disclose trauma or a hereditary basis.

CAMPBELL[30] reports the biopsy of a left tibia mass consisting of a bony shell with dense cancellous vascular interior. At places the shell was cartilaginous. There was no distinct base and the interior of the base was continuous with the marrow cavity of the tibia. Nearly all of these exostoses removed show a covering of more or less glistening cartilage and are covered with periosteum.

Spongy exostoses generally develop at the metaphysis of the long bones at the ends that show the greatest per cent. of growth in length, namely, the lower end of the femur, both ends of the tibia, proximal ends of the fibula, proximal ends of the humerus, distal ends of the ulna and radius.

HIGBY[13] reports the following showing the relative per cent. of growth in length of the following bones:

PROPORTION OF WHOLE DIAPHYSIS

	Formed from Proximal End of Diaphysis	Formed from Distal End of Diaphysis
Femur	31 per cent.	69 per cent.
Tibia	57 per cent.	43 per cent.
Fibula	60 per cent.	40 per cent.
Clavicle	62 per cent.	38 per cent.
Humerus	81 per cent.	19 per cent.
Radius	25 per cent.	75 per cent.
Ulna	19 per cent.	81 per cent.

OBERNDORF[10] under "Spontaneous Disappearance" states that Hartman[3] reports a case of great diminution in size of a bony tumor in multiple exostoses which he actually observed and that Starck[4] relates that according to the statement of a trustworthy patient, several bony tumors appeared and vanished completely as in Oberndorf's case. The latter points out that these authors report all the tumors absorbed before the patient reached his full growth. Oberndorf[10] reported a case of spontaneous disappearance in a German nineteen years old. Davis[6] reported a case where the tumor diminished in size.

BOGGS[37] says, "The cartilaginous covering of the exostoses is irregularly distributed and disappears during puberty when growth of the tumor ceases. Later some absorption may take place. In a few cases the tumors have entirely disappeared."

PERCY[15] reports a case, also WHITE[27] a case of a twenty-six-year-old patient with tumors from the humeri which were cartilage-capped.

GIBNEY[2] refers to a case in a boy of ten years in which an exostosis was broken

loose from its attachment and was completely absorbed in a year; also another case in which the doctor himself broke an exostosis from the bone near the knee but it reattached itself at another point.

COLE,[31] quoting from Bentzen says, "The pathological processes in the bony tissue may be assumed to be related to the phenomena seen in the formation of callus."

JENKINSON[25] says, "Exostoses may be either of two types, the flat table top or the irregular cauliflower variety. They are definite bone producers and show no invasion."

CAMPBELL[30] concludes, "The lesion is most typical and in greater abundance at those sites where growth is most rapid."

PAGET,[38] who always built upon the solid rock of fact, observed, "The bones of the hands are their most frequent seats; and next to these, the adjacent extremities of the femur and tibia, the parts which for some unexplainable reason appear to have in all the skeleton the least power of resistance of d i s e a s e. After these, the humerus, the last phalanx of the great toe, the pelvis and the ribs a p p e a r most l i a b l e to cartilaginous growths."

Spurs are not uncommon and are to be found in my cases.

"The periosteum of the affected bones is to a moderate degree thickened and shows evidence of abnormal activity," states Christian.[39]

The lime salts are

FIG. 11.—Lower and upper ends of left fibulæ. Abnormal development practically identical.

contained in greater amounts in the central portion of the tumors and the cortex of the bone shaft is continued into the dense bone of the tumors and the bone marrow likewise extends into the tumor. Observers in general have never noted the encroachment of such tumors upon the articular ends.

It was thought by some that the membranous bones were free from the formation of exostoses but reports of such occurrence show the frontal and occipital bones most frequently affected of those of the head. At the spheno-occipital junction is a typical site. The lower jaw a few times has been noted to be involved its entire length, Paget.[35] Halstead[21] reports one.

While the vertebræ are not so frequently affected, Ochsner and Rothstein[7] report an exostosis growing in the neural canal from the second cervical vertebra producing neurological symptoms from pressure.

All exostoses do not originate from the epiphyseal region.

Bones most often affected and their order are ulna, fibula, femur, tibia, humerus and phalanges, Davis[6] reports. For the most part they are distributed symmetrically.

Wright[4] in 1887 says that the sites usually selected are the ends of the femur, both ends of the tibia and the upper end of the os brachii.

Davis[6] states: "Many of the growths may appear within a short time or at intervals. The ulna, fibula, femur, tibia, humerus and phalanges are affected in most of the cases. They have been recognized from birth and therefore truly congenital."
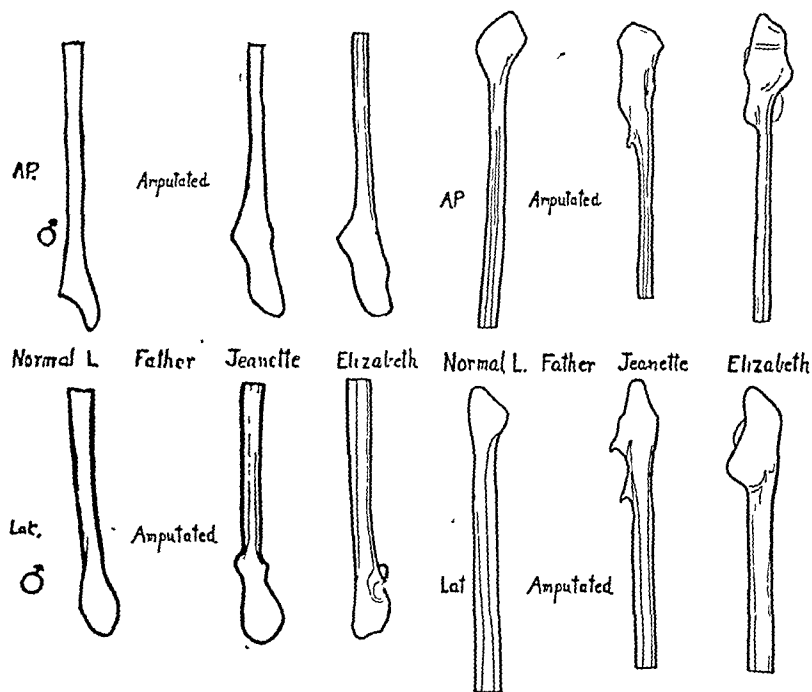
The spine, pelvis, ribs, clavicles and scapulæ are not involved so much as the long bones. The large exostoses are capped over with a bursa to prevent friction and at times free, hard bodies are to be found in them.

Secondary Skeletal Deformities.—The legs and arms are shorter than normal while the body is not affected. Patients with this disease are always short, some dwarfed as a cretin. The longitudinal centre of the body in these is some distance above the normal pubic centre.

In Ollier's disease, the shortening of the extremities affects only one side, while in chondrodysplasia it is generally symmetrical.

The unequal growth in length of the two pairs of parallel bones, the ulna and radius, and the tibia and fibula, is responsible for other deformities considered characteristic. The radius usually grows longer than the ulna because it is less affected 'tis said; however a study of the radiographs of the reported cases does not bear out this last statement.

If the wrist relations remain normal, the head of the radius at the elbow dislocates and at times the radius dislocates at the lower end, throwing the hand over to the ulnar side of the radius an inch or more above the wrist. See radiographs.

Instead of the above, the interosseous membrane may not be strong enough to withstand the strain so there is wide separation of the radius and ulna due to bowing.

When the fibula is greatly shortened, a high grade pes valgus develops and rarely varus. Scoliosis has been noted and the limbs are not always the same length. A composite picture of the extremities of all the affected extremities in a family with tumors might show a quite symmetrical length as I have noted in the metacarpo-phalangeal lengths of my three cases.

A deformed pelvis has been noted causing death in childbirth, Ehrenfried,[17] and the babe was affected. Long bones, as the leg and forearm and ribs, are sometimes bridged by exostotic processes.

"If excessive growth in the lower end of the tibia or ulna occurs, a pseudarthrosis or synostosis with the companion bone results," states Christian.[39]

This condition has often been confused with rickets because of a well-defined rosary, though both diseases may be present.

We can have deformed bones without exostoses, exostoses on normal bones and exostoses on bones with but slight deformities.
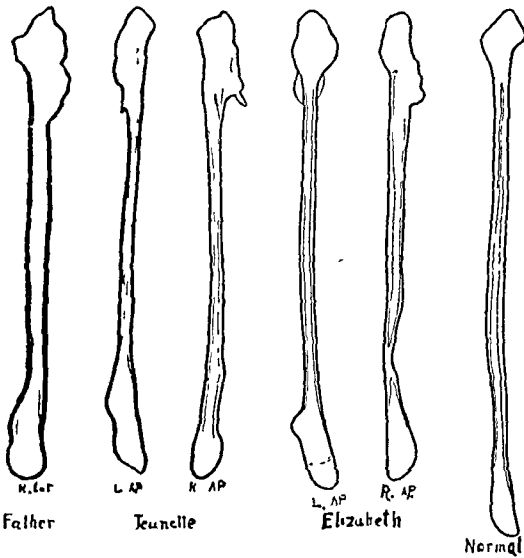

FIG. 12.—Shows the fibulæ of father and two daughters. All of equal length but much shorter in comparison to normal fibula of person of similar type and height.

The disease usually does not progress after maturity although Davis [6] reports the case of a patient fifty-three years old who began to develop tumors after thirty years and in a few months they disappeared.

Pronation and supination are often interfered with as found in two of my patients.

In many cases the lower end of the ulna is the so-called arrowhead deformity. See radiographs.

There is no definite relation of the length of the bones to the amount and size of the exostoses but observations on my cases bear out the statement made by Ehrenfried [19] which denies Davis' [6] statement on this point. The heights of my patients are 55, 59 and 61½ inches respectively. Davis [6] states: "It is possible that the decrease in length is proportionate to the interference with destruction of the epiphyseal cartilage and not to a simple exhaustion of the osteogenetic supply."

Enchondromata are more common in the feet and hands than are exostoses. The tarsal and carpal bones are free from dyschondroplasia. In a study of 682 fractured bones, we found but two carpal bones fractured and eleven tarsal bones. The sternum seems to escape both conditions extremely well, too.

Complications.—Degeneration in the tumors has been known to cause cysts. This may be due to lack of blood supply or to pressure. Reports of blood-vessel injury and aneurism due to friction, particularly of the popliteal artery are reported; Freiburg, of Cincinnati, having reported such an aneuism years ago. The urinary bladder has been perforated by a spur of this nature, likewise the pregnant uterus. Pelvic exostoses have caused the death of a woman in childbirth. Infection of overlying bursæ have been noted. Ehrenfried [17] found that about 5 per cent. of the reported cases were complicated by malignant osteo-cartilaginous tumors.

CAMPBELL [30] reports a typical case, the father dying of cancer of the stomach, the mother of cancer of the throat. Case I, father of Cases II and III of my own herein reported, had his left leg amputated for so-called giant-cell osteosarcoma at the age of twenty-nine years and at thirty-eight years had two epitheliomas removed from his forehead.

Neurological Complications.—Oberndorf [10] quotes from Starck a case of "spastic paralysis" of the legs, probably through pressure on the cord due to an exostosis in the neural canal of the third dorsal vertebra. Oberndorf [10] reports a fatal case in a patient who had analgesia and thermoanæsthesia due to pressure on the cord area.

Ochsner [7] describes a case with an exostosis nearly filling the neural canal of the second cervical vertebra with cord pressure symptoms on the right side of the cord. Operation.

Dwyer [21] notes the following neurologic manifestations; acromegalic symptoms from a sella turcica growth and ulnar and radial nerve involvement.

Ehrenfried [17] reports two cases of the peroneal nerve in a hyperostosis.

Ashhurst [18] reports paralysis of the left ulnar nerve due to pressure of a bony mass in the neck of a boy of fourteen years while in a man of thirty years an exostosis on the left femur caused rheumatism by pressure on the sciatic nerve. The tumor was removed.

Cole [31] collected four cases of hemiatrophy of the face in Ollier's disease, this coinciding with the side involved. Bentzen, according to Cole, considered this an indication of a lesion in the upper sympathetic cord and experimented on rabbits, destroying the sympathetic cord and injecting alcohol in the region of the nutrient artery of a bone to
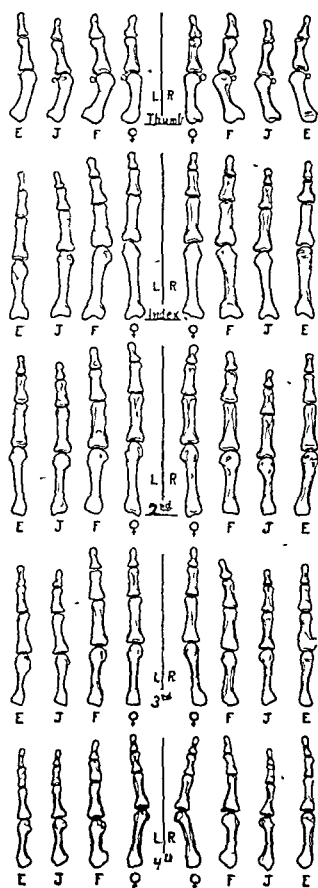
FIG. 13.—Comparison of the right and left carpo-phalangeal bones of the three patients and those of a normal similar type of individual. The abnormal development is mainly in the length of the respective units. See Fig. 14 for graphic representation.
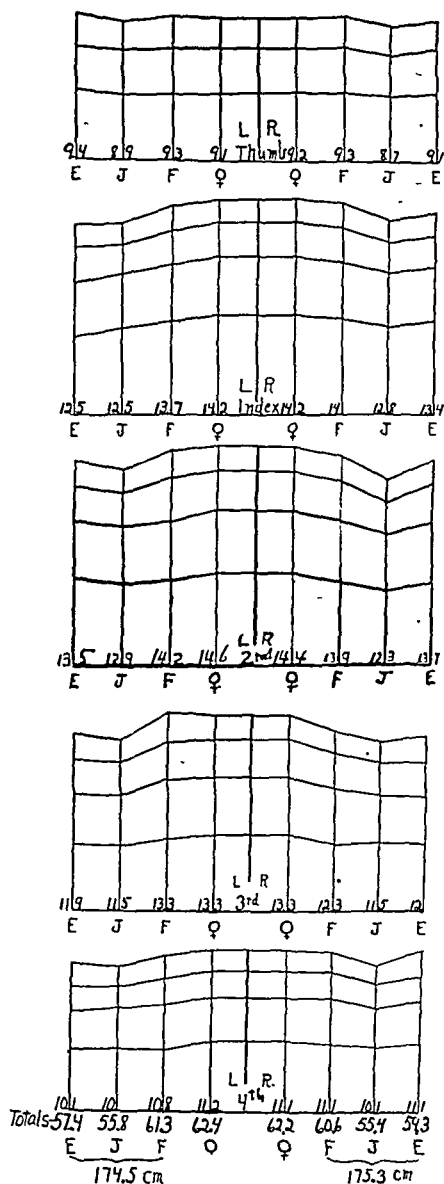
FIG. 14.—Graphic representation and measurements of the units of the right and left carpo-phalangeal bones showing how nature has balanced the total lengths of these bones of the right and left hands to within a difference of only 8 millimetres. A very remarkable endeavor on the part of nature.

knock out the sympathetic. He obtained results in two cases analogous to the appearance of bones in Ollier's disease.

Most writers are now of the opinion that this is identical with chondrodysplasia because in some cases a few exostoses can be demonstrated on the normal side. While at least one case report I found showed a typical case of chondrodysplasia transmitting but a few tumors to an offspring.

Cleveland[36] was able to collect fifteen cases of Ollier's disease in the literature, including his own.

A few years' study into the genealogy and the offspring of this small group of individuals certainly would clear up the much-disputed point of whether Ollier's disease is a distinct clinical entity.

The reports of my cases are herewith presented.

CASE I.—J. B., aged fifty-eight years, male, married, height 55 inches, weight 180 pounds, discovered at seventeen years of age a small lump on the inner side of his left knee with no history of injury. The lump gave him no pain or discomfort for eleven and one-half years, then he complained of stiffness in the left knee and the tumor
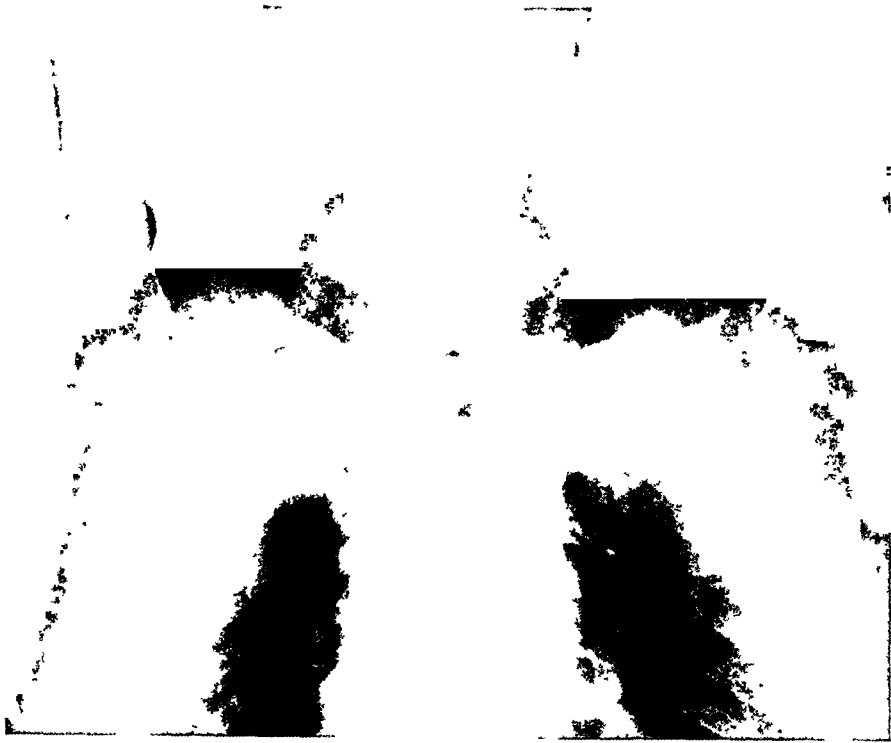
FIG. 15 —Humeri of Case I.

increased to a circumference of twenty-two inches in six months. The knee had to be immobilized to give him any comfort. He was examined by Dr. J. E. Russell,[5] of Cincinnati, who reported the case as sarcoma in the *Eclectic Medical Journal*, vol. lx, 1900. The following is quoted from his paper.

"An X-ray of the tumor gave a shadow showing a great enlargement of bone tissue with serrated edges protruding with the soft tissue. Limb amputated December 20, 1899, at Cincinnati General Hospital. Stump left, allowing for use of artificial limb. In case of a recurrence in the osseous structure, the bone could easily be removed. Uneventful recovery. Examination of the photo-engraving shows that the condyles of the femur remain normal and free from the malignant cell growth. It will be seen that the bone was excavated and that a very thin shell was all that remained to hold the limb from fracture and destruction. Photo-engravings show the different malignant cells."

The patient has never been able to wear an artificial limb.

Past History.—He had two epitheliomas removed from his forehead at thirty-eight years of age. He believes that he fractured his right arm below the elbow in childhood. Other history irrelevant.

Family History.—Father's left leg was greatly enlargéd and had a "sore" on it. No history of bone tumors in the family.

The sites of exostoses will be noted and compared with the cases of the patient's two daughters at the end of these case reports.

CASE II.—J. B., daughter of Case I, female, aged nineteen years, single, height 59 inches, weight 109 pounds, short, stocky stature, at five years of age had a bone tumor the size of a hickory nut removed from her left humerus three inches from the shoulder by Dr. J. E. Russell. The patient grew normally but the left arm was never as long as the right. At thirteen years, a hard mass was discovered on the inside of the left thigh three inches from the knee. She was lame for eight years, swinging her left hip around favoring that side. A few years ago she complained of sharp, catching pain in the tumor region and got relief by swinging her leg. The tumor has grown at about the same rate as her body growth.

Past History.—Has had rheumatism in her right knee; thirty boils on her head before one year old, goitre in early adolescence, bronchitis every winter until recently and has always been nervous.

Family History.—Father and one sister have multiple exostoses; one sister and one brother and his little daughter are free from these tumors.

CASE III.—E. B., daughter of Case I, aged fifteen years, single, blond, height 61½ inches, weight 96 pounds. When she was a few months old a three-cornered knob was discovered on her right arm about two inches below the elbow on the posterior surface. At one year of age she fell, throwing her arms out to catch herself. After this the knob disappeared. At this time, it was thought that she had fractured her arm and she complained of pain. At twelve years, while carrying a shovelful of coal, something snapped in her right arm above the wrist. She could push the bones into different positions until she could get relief from pain. She is unable to lift anything with this arm, which is not growing so rapidly as the left. She has been lame until recently, favoring her right side. She is knock-kneed and cannot bring her ankles together. At twelve or thirteen she complained of pain shooting from her left shoulder into the left side of her body. Was unable to lie on her left side and also complained of pain around her left hip-joint and of "catches" in her left knee.

FIG. 16.—Shows shortening and bowing of radius and ulna in Case III.

Past History.—She had pneumonia at five years, the usual childhood diseases, tonsillectomy at eight years and operation for tuberculous peritonitis at thirteen years. *Family History.*—Same as Case II.

Occurrence of Exostoses in these three cases.—*Right Humerus.*—Case I.—From the anatomical neck it is affected for 11 centimetres down the shaft, quite irregular; bone tapers down to 3 centimetres; some irregularity about the internal condyle. Case II.—Similar affection except lower end is negative. Case III.—Slight thickening of periosteum in mid portion.

Left Humerus.—Case I.—Upper portion 12.5 centimetres down the shaft is irregular in outline, averages 5 centimetres in diameter; has characteristic longitudinal striations with very thin cortical bone. Cases II and III present proportionately the same condition.

Clavicles.—Inner portion thickened in each case. Cases I and II have thickening of the acromial ends and Case III has an exostosis on this end.

Right Radius.—Case I.—Marrow cavity larger than normal; thickening of bicepital tubercle; head greater diameter than normal, suggestion of exostosis 6 centimetres from lower end with thin cortex and irregularly shaped marrow space and has more bowing than the left radius. Case II.—Thickening at the wrist for 4 centimetres up the shaft; 1 centimetre longer than the ulna at wrist and has slight outward bowing. Case III.—Marked bowing; some increase in size of bicepital tubercle; lower end 2.5 centimetres to 3 centimetres thick for distance of 6 centimetres; small spur on external surface.

Left Radius.—Case I.—Irregularity with tendency to slight exostosis near the head and thinning of the cortex; thickening and enlargement of the lower end; slight bowing. Case II.—Outward bowing; .5 centimetre longer than ulna at wrist. Case III.—Lower 5 centimetres thickened with small exostosis in similar position to spur on right radius.

Right Ulna.—Case I.—About 2.5 centimetres short; outward bowing; thickened for about 5 centimetres; does not engage in wrist-joint articulation; typical arrowhead deformity. Case II.—Flat exostosis 2.5 centimetres above rounded end. Case III.—Marked bowing; 2.5 centimetres from wrist articulation attached to side of radius.

Left Ulna.—Case I.—Exostosis size of a split pea on the coronoid process about 1 centimetre from articular surface; outward bowing at junction of upper and middle thirds. Case II.—Flat exostosis 2.5 centimetres above rounded lower end. Case III.—Does not articulate in normal manner to side of radius.

Right Femur.—Case I.—Greatly thickened and short neck; greater trochanter practically on level of top of the head of the femur. The former is much thickened, has longitudinal striations; lesser trochanter increased in size; shaft thickened a distance of 12.5 centimetres from lower end; crater-shaped exostosis on inner side 1.5 centimetres high attached along base 5.5 centimetres; two spurs 1 and 2 centimetres on outer side 9 centimetres from articular end and point upward; cortex thin; longitudinal striations; small round body in posterior part of knee-joint. Case II.—Head of bone similar to above; no exostoses; cancellous architecture abnormal; uniformly thickened shaft for 10.5 centimetres from the articular end; slight spur on posterior surface and a small round body in the posterior part of the knee-joint. Longitudinal striations; small spur 5 centimetres from lower end; inner side has one sharp and one globular spur about 10 centimetres from end; average diameter of shaft 6 centimetres. Case III.—Head similar to above; neck has tendency to vertical direction; two spurs at lower end on external surface directed upward, 2 centimetres and 5 centimetres from the epiphyseal line respectively; slight exostosis on inner surface; longitudinal striations.

Left Femur.—Case I.—Shows entire stump left from amputation; head similar to right side; round exostosis developing from neck 3.5 centimetres by 3.5 centimetres with broad base; spur 2 centimetres long on end of stump; longitudinal striations. Case II.—Similar to Case I. Also small rounded exostosis below greater trochanter externally; at lower end, lateral view shows cauliflower exostosis 8 centimetres by 8 centimetres with rather broad pedicle and has cancellous structure and longitudinal striations. Antero-posterior view shows same large exostosis and two or three small spurs on the external surface 6.5 centimetres to 10 centimetres above the knee-joint; longitudinal striations. Case III.—Not as thick as right side; slight exostosis above the lesser trochanter and neck; lower end similar to right.

Right Tibia.—Case I.—Upper end at knee widened; cortex very thin; some longitudinal striations; exostosis where it articulates with fibula also at lower end and has lateral contact with fibula for 4.5 centimetres; appears to be a synarthrosis and seems to have a depression in lateral aspect of fibula along this attachment. Case II.—Small exostosis on inner tuberosity 4.5 centimetres from end with longitudinal striations; lower end shows lateral thickening with small exostosis on external surface 3 centimetres from end. Case III.—Slight broadening of the upper end; some tendency to exostosis

at articulation with fibula; lower end has marked exostosis 6 centimetres above epiphysis 4 by 2 centimetres. Laterally it is pedunculated and has caused considerable absorption of inner surface of the fibula due to pressure.

Left Tibia.—Case I.—Leg amputated. Case II.—Similar exostosis as on right upper end; flat, plateau-like exostosis on fibula side of bone about 5.5 centimetres in length; very small flat exostosis over internal malleolus; tibia and fibula intimately united. Case III.—Moderate sized exostosis on inner surface of tuberosity; long spur 2.5 centimetres at junction of·upper and middle thirds.·

Right Fibula.—Case I.—The head of the upper end shows marked enlargement for 7.5 centimetres; irregularly shaped; longitudinal and transverse striations; greatest diameter about 8 centimetres; globular-shaped exostosis hangs down on inner aspect between tibia and fibula 3.5 centimetres by 1.5 centimetre. Lateral view presents cystic appearance; a small round cartilaginous body is in posterior aspect of joint. Bone angulates at 8 centimetres from its lower tip. Case II.—Upper end considerably enlarged and involved for 7 centimetres; two spurs, 3 centimetres in diameter are at the lower portion of that area directed downward; at lower end an inward angulation about 7 centimetres above the end on the inner side present. Case III.—Marked thickening of the head affecting the diaphyseal end; spur on this part; lower portion of bone absorbed by pressure by exostosis on tibia.

Left Fibu'a.—Case II.—Upper end similar to right; shaft narrower than right; considerable thickening for 7 centimetres of lower end; rounded exostosis towards tibial side causing a firm union between the two bones. Case III.—Typically involved but not to extent as on the right; exostosis 3 centimetres on inner surface of lower end.

Scapulæ.—Case I.—Some irregularities in axillary and vertebral borders; great thickening of neck and glenoid cavities; hanging like a drop on either coracoid process is an exostosis 2 centimetres long and 1.5 centimetres in diameter. Cases II and III present the latter condition.

Ribs.—Case I.—Marked exostosis 4 centimetres in diameter on third rib on left side, 3.5 centimetres from head of rib, presses against the upper surface of the fourth rib causing downward bowing and appears to be attached to the rib. Case II.—Calcification of cartilages on left side. Case III.—Slight affection of right third rib near spine.

Hands.—Case I.—Irregularity in length of metacarpal and phalangeal bones with slight equal affection of the phalanges of both hands. Case II.—No exostoses but irregularity in outline and difference in length of bones. Case III.—Irregular slight affection of metacarpal and phalanges. Marked irregularity.in length of bones.

Feet.—Case I.—Slight affection of metatarsal and tarsal bones; short spur at base of first metatarsal. Case II.—Minor involvement of metatarsals and phalanges; tendency to tumor formation. Case III.—Same as Case II excepting latter condition.

Pelvis.—Case I.—Irregular in shape due principally no doubt to weight bearing performed by the right leg; irregularity in symphysis pubis; pubic rami thickened and slightly irregular; minor changes in iliac crests, left larger than right somewhat. Case II.—Distortion of rami of pubic bone; irregularity in outline; abnormality of symphysis; exostosis near the crest of both iliac bones about 3 centimetres in diameter. As they are observed through the bone, it is impossible to say whether they are inside or outside of the bones. Case III.—Similar to Case I; wide separation of pubic bone.

The Etiology of Chondrodysplasia is unknown. It leads us to revolve in our minds the various diseases affecting the development of the skeleton for it is classed in the same category. Rickets is the first to be thought of, osteomalacia, fœtal chondrodystrophy, dwarfism, giantism, osteogenesis imperfecta, acromegaly and cretinism; while rickets may be associated with this disease still the microscopic changes are entirely different.

Because thyroid disease has the same geographic distribution as chon-

drodysplasia, some have thought the thyroid an etiologic factor. We would expect more uniform affection of the skeleton in cases of endocrine disturbance. It would be hard to believe in such a cause for Ollier's disease. However a trophic disturbance of the central nervous system would fit in more reasonably with the facts observed. Neuro-syphilis if the above were true certainly would account for some cases but syphilis has been proven to play no part in its causation.

. Infection has been thought to be a cause. With this idea in view I fed blood and saliva from my patients to fifty pairs of white mice but was unable to obtain bone tumors in any of their progeny.

Tuberculosis is probably the most commonly associated disease; the reason given for this is that the general resistance of these patients is low. One of my patients, Case II, was operated upon by me for an accumulation of tuberculous fluid about her appendix region during the course of my study of her skeletal system. Her recovery was uneventful.

Keith,[23] who is an anatomist striving to get a peep into nature's growth mechanism, says: "This disorder should be definitely placed among the disorders of growth." After weighing the facts of the various theories I am convinced that Keith is correct. However he describes in a very convincing and interesting way what takes place in the development of these tumors but leaves us wondering what causes the periosteal ferrule, as he calls it, to lag behind in its growth. But the germ plasm will give us no answer to our question for we will find the mystery hidden in the somatoplasm. In my three cases heredity unquestionably exists. It is now taught and believed that the soma has no influence upon the germ plasm due first to the teaching of Weissman and second to lack of convincing evidence to the contrary. While long ago Lamarck in his "Zoölogical Philosophy" taught that acquired characters are transmissible, thus clearly explaining the variations seen in fossils and laying firmly the foundation for evolution a theory of use and disuse of parts years later. While every scientist accepts the theory of evolution proven so abundantly in the field of paleontology, still practically to a man, they deny somatic influence upon the germ plasm.

Doctor Parker, of Harvard, in a series of lectures at Ohio State University on evolution and kindred subjects said he would like to believe in the inheritance of acquired characters but that every scientist who has attempted to prove it has met disgrace and consequently no self-respecting scientist today will espouse its cause.

Even the pet idea of Darwin, natural selection, according to Doctor . Parker does not work, if at all, in the grand style of its creator. Weissman's argument against the inheritance of acquired characters was based upon the experiment of cutting off animals' tails with negative results in the offspring.

Common sense would tell one that all the fundamental plans of organization and function in order to preserve and perpetuate the specie would have to be laid down at a time before the individual was exposed to the vicissitudes of environment. However this does not preclude the influence of

refined and minor cumulative somatic influence and in rare instances possibly grosser somatic influence; to wit: a neighbor of mine when a boy had his left arm and leg amputated by'a railroad car and he had a daughter with a half-length left arm. This may be merely a coincidence.

To expect a result such as Weissman argued against, one would have to remove the anlage of a tail or other part before it could influence the germ plasm to get the desired effect. This is really what happens when experiments are made upon eggs in the pre-gastrula stage, the so-called vital record or directing force of ontogeny is wholly or partially destroyed.

FIG 17 —Case II.

I have spent many years experimenting upon the eggs of fresh water snails and by various physical and chemical means, a great chain of monsters was obtained grading from those of a few live cells through shell-less forms and a perfect grade of shells from a mere flat disc to the perfect normal stage. To my mind these monsters represent evolution in retrospect.

In many respects a germ cell is similar to a nerve or brain cell and while the latter can have all kinds of environmental influences recorded in or upon it in a manner still unknown to science, yet a visit to a museum of paleontology certainly will convince one that something has been added to or subtracted from the germ cells that produced the specimens one sees when

compared with the early and late members of the specific form; an example is the horse.

To understand this marvelous fact, we must assume that there is a mechanism in the germ plasm which is more or less responsive to the environmental experiences of the soma, although it may require thousands of years to make changes. Every differentiated or undifferentiated cell in the body can be traced through an unbroken chain of cells to the germ cells from which they sprang.

In the case of bilateral animals, the gastrula consists of two sets of similar cells but they are right and left handed. At the end of this stage experiments upon the eggs have no effect on the final result, thus showing the controlling mechanism is fixed at this stage, a well established fact.

So theoretically we represent graphically the descendant cells of each gastrula cell by a figure like the web of a spider. It is bilateral and the spiral threads serve to keep the two sides coördinated and timed. Now if we assume that this figure possesses all plans or records of the mature animal and capable of controlling all the intricate processes of ontogeny, we have exactly the figure that I discovered in the egg of the physa, a fresh water snail. It is situated just beneath the inner cell membrane and definitely oriented in the egg.

Many years of experimenting on these eggs have inclined me to believe that it controls the ontogeny of the snail for when the gastrula stage is drawn into capillary glass tubes, development continues while earlier stages so treated stop at the gastrula stage because they have been removed from the influence of the controlling mechanism, I assume.

Reversion of animals or birds to some former condition is a well-established fact, an example being the reversion of a domestic pigeon to the rock pigeon as described by Darwin. Every flower gardener knows how quickly certain flowers become wild again. Just as individuals may be born having lost most all of the parental distinguishing characteristics, having reverted, others may come forth as described first by De Vries, a Dutch botanist, a new species, a mutant or sport.

A record of the new character must have been carried through hundreds or even thousands of parents perhaps, each adding its bit of experience which undoubtedly the germ plasm was able to record. Finally this experience becomes dominant and able to assert itself and the mutant is created. Time and experience are the two important factors plus an adequate and marvelous recording mechanism which is apparently as intelligent as instinct, in fact if they are not the same thing, they walk hand in hand and of equal kin to chemical affinity.

After reading Sir James Paget's article on cartilaginous tumors an idea occurred to me that multiple exostoses may be due to impressions made upon the germ plasm consequent to fractured bones and their complex healing processes in past generations to the number sufficient to afford at least one record for every bone, right and left, that is affected in a typical

case of multiple exostoses. Just how many times a particular bone or group of bones must be fractured and through how many individuals their records must be carried before an individual blossoms out as a sport or a mutant with a crop of exostoses able thereafter to transmit the same to offspring in a Mendelian fashion, I confess my inability to answer.

Furthermore as all kinds of fractures occur during youth while the epiphyseal cartilages are still active and possibly able to make some sort of germ plasm impression or record of the injury; we have a further reason for believing it possible to record upon the germ plasm for the carpal, tarsal and vertebræ are so infrequently fractured during the first age period that they remain practically free from tumors.

No doubt many individuals do not possess the full measure of the protective barriers nature has furnished in a special mechanism which protects the germ plasm from abnormal influences. Theoretically, it is not necessary for the first individual affected to have a full complement of tumors. There is proof that a patient with a typical set of tumors can transmit to an offspring only a few tumors. Of course all children of an affected parent are not affected.

The hereditary nature of single exostoses has not been studied very carefully. Their distribution, however, is rather typical of the hereditary affection. Patients with a single exostosis may belong to a susceptible type analogous to Maud Slye's mice that show a predisposition to cancer and a trauma may initiate an exostosis.

The spontaneous disappearance of exostoses, a well-established fact and observed in one of my patients, seems somewhat analogous to the absorption of callus in fractures.

Exostoses most commonly occur on the end of the long bones that have the greatest per cent. of growth in length.

In order to offer some proof in favor of my evolutionary theory of exostosis, Miss Kathryn Williams, who made the X-ray films of my three cases, undertook the study of our records of 682 fractured bones that have been radiographed in our private laboratory during the past few years. What I had in mind was to check up on the sex ratio, the bones most commonly fractured, the site of injury and the age incidence.

We assume that germ plasm impressions would be more easily made during the first age period, one to twenty years, but it is quite possible that it may be active through life, but in the female after forty these impressions would be rendered practically impotent because of the end of the reproductive period. In the male, however, reproduction often occurs late in life. This point should be considered in a study of the sex ratio 3 to 1.

The statistics Miss Williams presents are as follows:

In 682 fractured bones 451 were males and 231 females; 25 per cent. of the male fractures and 23 per cent. of the female fractures were due to automobiles. The number of bones fractured on the two sides of the body was found to be equal in both sexes.

In the male miscellaneous cases, there were more fractured by fifty-six on the left side than the right but the automobile fractures have a ratio of three right to one left; while the female fractures are equal in both auto and miscellaneous cases.

The ratio of male to female is 2 to 1; in miscellaneous cases, 3 to 1; and in auto cases, 2 to 1.

The bones most frequently fractured are given in the order of occurrence in 521 miscellaneous fractures, not automobile.

Radius 20 per cent.	69 per cent., lower third	50 per cent., 3rd age period
Humerus 12 per cent.	50 per cent., lower third	84 per cent., 1st age period
Femur 11.7 per cent.	81 per cent., upper third	92 per cent., 3rd age period
Ulna 11 per cent.	60 per cent., lower third	55 per cent., 3rd age period
Tibia 9.6 per cent.	76 per cent., lower third	63 per cent., 3rd age period
Fibula 9.6 per cent.	66 per cent., lower third	51 per cent., 3rd age period
Phalanges 3.2 per cent.		17 per cent., 3rd age period
Head 3 per cent.		18 per cent., 3rd age period
Pelvis 3 per cent.		31 per cent., 3rd age period
Metacarpus 2.8 per cent.		$6\frac{2}{3}$ per cent., 3rd age period
Metatarsal 2.6 per cent.		42 per cent., 3rd age period
Tarsal 2.3 per cent.		45 per cent., 3rd age period
Clavicle 1.9 per cent.		20 per cent., 3rd age period
Ribs 1.9 per cent.		50 per cent., 2nd age period
		40 per cent., 3rd age period
Scapula 1.1 per cent.		43 per cent., 3rd age period
Vertebra 1.1 per cent.		100 per cent., 3rd age period
Phalanges (foot) 1.1 per cent.		$33\frac{1}{3}$ per cent., 3rd age period

I believe these figures will speak for themselves when compared with the statistics on hereditary chondrodysplasia. If this increase of 25 per cent. of fractures due to auto accidents continues, one might imagine what effect it will have upon the human skeleton 50,000 years hence. If this evolutionary idea is correct, then we have at last a real proof that the soma can influence the germ plasm.

It is said that these tumors occur in animals but they must be extremely rare for it would be a simple matter to detect them in the cuts made from millions of slaughtered animals. The reason for this is that most animals are destroyed when they have fractured legs. While in wild life, the injured are always preyed upon by their own or other species and consequently there is small likelihood of such injured animals being able to survive and perpetuate themselves, while in man, the moral sense has saved these individuals through man's power to aid nature in her healing process, particularly in those of bone repair.

Symptoms.—Outside of partial loss of joint function from a large exostosis or pain from a pointed exostosis, most of the symptoms are due to the various complications already mentioned. Many patients are practically symptomless and entirely ignorant of the presence of the disease.

Diagnosis.—Most cases are easily diagnosed from the X-ray films as the appearance is quite characteristic.

Treatment.—No treatment is indicated except to facilitate joint function or to correct a deformity that is disabling. Maturity is the time indicated for corrective operations. Many of the complications demand surgical interference.

Remarks.—I have been interested for many years in the study of neoplastic and malignant growth through the viewpoint of embryology and cytology. The present I think affords a lot of stimulus for study and observations along this line.

If my assumption of the cause of chondrodysplasia has a grain of truth in it, we then have a glimpse of the entire cancer sequence, for 5 per

FIG. 18.—Case II shows large exostosis on lower end of left femur.

FIG 19.—Case III. Note exostosis on lower third of right tibia pressing into fibula.

cent. of these tumor patients develop malignant bone growths. Cancer patients in general might be considered to have been made susceptible through transmission from past generations of various obnoxious environmental experiences.

It is known that farmers, teamsters, laborers and those exposed to the irritation of sun, rain, cold, wind, dirt and other irritations are more susceptible to skin cancers of the face and hands than those not so exposed. I think a long list of gastric ulcers in a patient's genealogy is far more potent for cancer than the possession of an ulcer itself.

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TRANSACTIONS

NEW YORK SURGICAL SOCIETY

STATED MEETING HELD MARCH 12, 1930

The Vice-president, Dr. John Douglas, in the Chair

SUPRA-ORBITAL EPITHELIOMA

Dr. Robert H. Kennedy presented a man, aged sixty-three years, who was admitted to the Beekman Street Hospital June 11, 1926. Six weeks before admission he had developed a small lesion above the right eyebrow which appeared to be a furuncle. He was certain that there had been no lesion at this site previously. It broke down and discharged pus, but then failed to heal. He came to the clinic for about two weeks before hospital admission, where on account of the sluggish healing a biopsy was made and reported to be squamous-cell epithelioma.

When admitted there was an ulcerated circular lesion in the right supra-orbital region two centimetres in diameter. The edges were raised but only slightly indurated and there was a sloughing base apparently not attached to bone. One hard, freely movable node was present in the right parotid region. There were several small shotty nodes in the posterior cervical triangle. June 14, under local anæsthesia, the area was excised down to the deep fascia with normal skin one centimetre wide surrounding lesion. The skin was undermined and closed, the upper and lower eyelids also being sutured together to prevent ectropion. The lymph node was then dissected from the parotid region and skin closed. The wounds healed by first intention. *Pathological Report.*—Squamous-cell epithelioma in both lesions.

Due to the metastasis found after a history of six weeks only it was felt that the condition was a highly malignant lesion, and that further operative procedure would not be proper. However, he was given a thorough course of X-ray therapy to the parotid region and the cervical lymphatics.

He has been seen frequently in the follow-up clinic. Some soft nodes have been felt constantly in the submental and both carotid regions. They have not changed and are probably due to mouth infection. The patient insists that they were present for a number of years before operation. It is now three years and nine months since operation without evident recurrence. He was presented as an example of prickle-cell or squamous-cell epithelioma of the skin not arising on an old scar and not at a muco-cutaneous junction. Such lesions on the face are most likely to be considered basal-cell epitheliomata which respond readily to treatment by radiation. Squamous-cell epithelioma, however, responds poorly to radiation and such patients should be advised to have such a lesion excised if it has not disappeared after two treatments by radiation. If it proves radioresistant there is a real possibility that one is dealing with a prickle-cell lesion of the skin which is not rare and which demands thorough surgical treatment. A basal-cell lesion does not metastasize at any time, but a prickle-cell lesion may metastasize early, as seen in this case. This patient also demonstrates the value of early biopsy in a lesion which fails to respond to treatment.

Dr. George H. Semken said that the usual types of epithelioma found in the skin of the face are the basal-celled and the squamous-celled. The basal-celled types were definitely classified by Krompecher in 1903 (in his monograph "Der Basal-cellen Krebs"). A third type of epithelioma, the "intermediate" or "mixed" type, was added by Darier in 1922 (*Annales de Dermatologie et de Syphilographie*). All three types have a common ancestry in the germinal layer of the epidermis; but while the basal-cell type retains the fœtal, cuboidal form throughout and grows in nests and strands, the squamous-cell type undergoes differentiation through the prickle stage to keratinization in varying degrees, and is irregularly invasive. The intermediate or mixed type is made up of both types of cells, some remaining cuboidal and others being differentiated in the form of squamous cells. It probably constitutes a true type with mixed genetic factors, rather than a transition from basal cells to squamous, during the tumor development, as was formerly believed. The basal-celled epitheliomata are considered radio-sensitive while the intermediate and squamous-celled types are radioresistant. It would not be wise, however, to apply this criterion in the clinical attempt to determine the histological structure of any of the epitheliomata, as Doctor Kennedy suggested, for many of the basal-celled epitheliomata have proven radioresistant also, in part or whole. With so serious a process as cancer, it would seem wisest to remove the lesion completely, in a definitely certain manner, by one of the recognized methods of surgical extirpation. If this is done properly, there need be no question as to what the resultant scar contains. On the other hand, there is no means of knowing what is in the scar produced in an apparent cure by irradiation with radium or X-rays; and experience has shown frequent recurrences in such scars, from the growth of radioresistant portions of the epithelioma which the fibrosis produced by this treatment could only delay but not prevent.

Cancer growth is expansile and invasive. Expansile growth produces prominent tumor projections, with little tendency to involvement of the deeper tissues; while invasive types may present an inconspicuous surface and a considerable carrot-like extension into the depth. It is highly important, therefore, in the excision of epitheliomata of the skin, to cut through the tumor immediately after it has been removed, and to make certain that the line of excision in the depth has been as certainly wide of the epithelioma as has been the more easily visible lateral margin. If the deep line of the excision has been too close to the tumor, more of the deep tissue can and should be removed at once.

Basal-celled cancers of the skin have been known to produce lymph-node metastases in only a few instances. Squamous-celled cancers of the skin are known to metastasize to the nodes, but this occurrence is not a common experience, and is rarely observed at so early a time as it has been found in Doctor Kennedy's patient. It is not necessary, therefore, to remove the regional lymph-nodes as a routine procedure in cases of squamous-celled epithelioma of the skin of the face; but when such lymph-node metastases

seem, clinically, to have occurred, and particularly when this clinical finding is verified by microscopic examination, then a comprehensive lymph-node dissection becomes a matter of the greatest importance. There may be but one invaded lymph-node (a localization frequently noted in cancer cases), and this seems to have been the condition in Doctor Kennedy's patient, since he has remained well in spite of the limited excision; but when the cancerous node is large enough to be clinically recognizable as such, it is more than probable that a microscopic advance guard of cancer cells has proceeded to lymph-nodes further on in the chain. The lymph-nodes seem to be provided, regularly, with a by-pass channel, which is utilized especially when the intrinsic lymph-node channels are blocked. With the presence of cancer metastases in the lymph-nodes, therefore, it is important to remove not alone the invaded regional group completely, but also the nodes beyond these in the lymphatic stream, to the widest extent practicable.

The regional lymph-node distribution can usually be determined for any region by a study of the veins. The main lymphatic vessels regularly tend to accompany the larger venous trunks; and this close association is probably referable to a close relation between the lymphatic channels and the veins in their embryonic genesis from mesoblastic angioblasts. In Doctor Kennedy's patient, the regional lymphatic path has been first to the nodes upon the parotid in front of the ear. From this station, the further path is through the superficial chain about the external jugular vein, at the angle of the mandible, and finally into the deep chain via the carotid packet, about the jugular vein, at the level of the carotid bifurcation. In the case presented, the length of time that has elapsed since operation, without recurrence, seems to indicate that there was a fortunate localization of the metastases in a single node; but it would be unwise to conclude from this experience that a limited lymph-node extirpation is ever a safe procedure, or that this patient may not still have cancer latent in the remaining nodes.

Doctor Kennedy rejoined that he agreed entirely with Doctor Semken that the ideal method of treating a case of this kind was to do a block dissection of the cervical lymph nodes. In this case, however, since operation for the removal of the lymph node in the parotid region had disclosed the fact that metastasis had occurred only six weeks after the appearance of the original lesion, the case was regarded as so malignant that further operation would be hopeless.

MELANOCARCINOMA OF THE ARM

Dr. Robert H. Kennedy presented a woman, aged thirty-nine, who was admitted to the New York Skin and Cancer Hospital November 6, 1926. Her family history was negative for known cancer. Five years previous to admission she had noted a dark spot on the left upper arm the size of the head of a common pin. This had been growing steadily since. She had consulted no doctor until coming to the hospital clinic three weeks before admission. At that time the lesion was one and one-half centimetres in

diameter and bluish black in color. It was excised widely under local anæsthesia. The pathological report was melanocarcinoma.

When admitted her physical examination was entirely negative for evidence of any metastases. November 8, 1926, under colonic anæsthesia the axillary tissue was excised *en masse*, including the sheath of the lower portion of the axillary vein. She made an uncomplicated recovery and was discharged one week later.

Since that time she has been seen frequently at the follow-up clinic and no evidence of metastases has become evident. She has had no X-ray treatment. It is now over three years and four months since the lesion was excised and over eight years since the patient noted that it was growing.

MELANOCARCINOMA OF BUCCAL MUCOUS MEMBRANE AND UPPER AND LOWER LIPS

DOCTOR KENNEDY presented a woman, aged forty-nine years, who was admitted to the New York Skin and Cancer Hospital October 1, 1927. Her family history was negative for known cancer. Fourteen years previously while undergoing dental treatment the right lower lip was pinched by an instrument. A "blood blister" followed immediately and a dark spot had remained at this site since. Two months before admission the dark area commenced to spread rapidly. She did not consult a physician until one week before admission. She had not lost weight.

Examination showed a bluish area on the mucous membrane of the right cheek extending back from the right angle of the mouth. This was raised about five millimetres and was ulcerated over an area three centimetres in diameter. The discoloration also extended onto the mucous membrane over the mandible involving up to the margin at one of the bicuspid teeth. The vermilion surface of the upper lip for one inch and of the lower lip for one and one-half inches from the right angle of the mouth was involved in the same bluish black discoloration. Small lymph nodes were palpable in the right submaxillary and carotid regions. The teeth were in poor condition.

While this lesion appeared to be melanocarcinoma, it was felt that with the long history, hæmangioma with pyogenic granuloma must be considered. The ulcerating lesion was therefore excised by actual cautery. The pathological report was melanocarcinoma.

In view of the site and extent of the lesion with the presence of cervical lymph nodes the case appeared inoperable. However, Dr. Franz Torek, who was in charge of the service, felt that the discomfort in the progress of such a lesion would be so great that an attempt at complete excision should be made. Consequently on October 12, 1927, under colonic anæsthesia the entire area was excised with the knife. This involved removal of almost one-half of the mouth opening and an oval extending back through the full thickness of the cheek for over five centimetres from the right corner of the lip. Mucous membrane and skin were brought together but no attempt was made to close the defect. The tissue removed at this operation showed only inflammatory changes. Fifteen days later, a strip of dark tissue one and one-half by one centimetre was removed from alongside the first lower right bicuspid, this having been missed previously. The pathologist reported melanotic cells present in this specimen also.

November 3, 1927, three weeks after the complete excision, a plastic operation was done, freeing the stump of the lower lip so that it could be anchored to the cheek. The upper and lower lips were not sutured together thus still leaving a considerable cheek defect. This gradually shrunk down to

its present condition. The only other operation was a swinging of a small flap of upper lip to improve the corner of the mouth. She was discharged from the hospital January 20, 1928, with a good functional mouth.

This patient has been seen frequently in the follow-up clinic and there is no evidence of recurrence nor metastasis. She has had no X-ray treatment. They have felt that it would be improper to open up the scar to improve the condition of the mouth or to remove the cervical lymph nodes while they showed no evidence of involvement. It is now two years and five months since operation.

The reporter added that surgeons are prone to consider melanotic lesions extremely malignant. A great many are highly malignant, but he did not believe that at present one could tell which ones. These two patients were shown to illustrate the prolonged course of some. A proper excision of a melanotic lesion never causes it to suddenly spread widely. The patient usually comes because a change has taken place in a preëxistent mole. Coincident with this activity, which probably means a change to cancer, metastases may have taken place and be microscopically present at the time the original lesion is excised, and go on to palpable metastases within a brief period. Not long since he had seen a patient who had had a too conservative excision of such a lesion on the sole of the foot three months previously. Over eight hundred metastases were counted in the skin and the X-ray showed one in the tibia, which was later proved at autopsy. Ewing states that some cases run an acute course proving fatal in a few weeks. In Kuttner's clinic thirty-nine cases of melanotic cancer were reported of which twenty-six were operated on. Four survived for five years, soon after which three died of generalized melanotic cancer. Some patients seem to present marked resistance to the progress of the disease, as Chauvin reports a woman whom he operated on four times in twenty-two years for such a lesion and Fye a case operated on three times in twenty years. Melanocarcinoma probably varies in its malignancy as much as any other type of cancer lesion.

Dr. Franz Torek remarked that melanotic tumors have one thing in common with all other malignant tumors; at some time they are localized and if they are seen at that time they can be just as successfully operated on as any other type of carcinoma. It is only when they have metastasized through the blood-stream that nothing can be done. Every surgeon is familiar with the experience of cutting out a melanotic tumor with a wide margin around the external appearance and of finding, as he goes into its depths, black spots extending some distance from the surface. If there were some way of knowing this beforehand one would not operate on such a tumor. Metastasis through the lymph-stream, however, does not contraindicate a surgical removal; the speaker had removed one fifteen years ago from the thigh of a patient in whom extensive black lymph nodes could be seen in the groin, and the man has remained well to the present time. As to the possibility of closing this large cheek defect without a flap plastic, formerly, Doctor Torek always planned the encouragement of new growth by flap plastic in large cheek defects, but in a case in which the growth

had been removed by cautery the cheek shrank so quickly that by the time it was possible to do the plastic, the defect was so small that a plastic was unnecessary.

DR. CONDICT W. CUTLER, JR., said that there may be manifested different degrees of malignancy of these tumors in different patients, as well as varying degrees in the same patient at different times. As illustration of this he cited a case on which he operated three years ago for swollen inguinal lymph nodes, which proved to be melanocarcinomatous. The only fact in the history which the patient gave which was relevant was that she had had a small, black wart removed from the vulva twelve years previously with no local recurrence. Two months after the radical excision of the inguinal and femoral lymph nodes there was a local recurrence, which was again removed. The patient subsequently complained of headaches and vomiting, began to vomit blood and died in a few weeks. Autopsy showed widely disseminated metastases throughout the body, involving the brain, and an isolated metastasis in the wall of the stomach which was ulcerated and which was responsible for the vomiting. Apparently it is possible for a growth of this type to be relatively non-malignant and go for a long time without showing the lymphatic metastasis which one would reasonably expect.

PAGET'S DISEASE OF THE VULVA

DOCTOR KENNEDY presented a woman, aged sixty-three years, who was admitted to the New York Skin and Cancer Hospital, November 20, 1929. She knew of no cancer in her family. For the past year she had had an irritation of the right side of the vulva without discharge or bleeding. During this time she had been under a physician's care and treated by various salves. Examination showed a lesion about the middle of the right vulva 3 by 2 centimetres and about 2 centimetres distant from the muco-cutaneous junction. This was raised, reddish-gray in color, a glazed surface, a suggestion of a pearly border, definite margin and seemed fairly superficial. No inguinal nor femoral nodes were palpable. The provisional diagnosis was epithelioma. The growth was excised under local anæsthesia, including a margin of normal skin 2 centimetres wide on all sides and carried to a depth of the muscle beneath. On cutting through the section it appeared grossly to extend little, if any, through the basement membrane. The patient made an uncomplicated recovery. The pathological report was Paget's disease of the vulva. Thickened epidermis with changes in the cells resembling Paget's disease, i.e., dyskeratosis and hyperchromatism with mitoses. It is now about four months since operation, and patient shows no local recurrence nor evidence of metastases.

This patient presents an uncommon type of lesion, although it is a question whether Paget's disease should be considered a clinical entity. The majority believe at the present day that the lesion is early cancer but views vary as to the origin of the Paget cells. These are recognized by their size, being usually larger than that of a normal prickle cell, their clear cytoplasm and the small deep-staining nuclei. He had been able to find thirty-five cases of extra-mammary Paget's disease reported in the literature. Five of these were on the vulva, and none seem to have been connected with deep-seated cancer, as is generally believed to be the case with Paget's disease of the nipple. The essential clinical features as given by Kilgore are, (a)

epidermal hypertrophy—in affected area two or three times normal thickness; sharply marked off at edge of lesion; (*b*) subepidermal round-cell infiltration; (*c*) so-called "Paget's cells," as described above. Fraser has the most recent article referring to this disease in the *New York State Journal of Medicine* of January 1, 1930. He believes that the cases of extra-mammary Paget's disease are usually intradermal tumors arising from the sweat ducts. Crocker, Rolleston and Hunt, and Sekiguchi had previously described extra-mammary Paget's disease as a primary carcinoma of the sweat ducts or sweat glands. From the site and appearance of this lesion it would conform well to this idea. In other words one is dealing not with a benign lesion, a precancerous lesion nor a secondary implantation, but with a primary carcinoma.

Dr. George H. Semken said that the desirability of burdening the name of Paget with a third disease is open to serious questioning. The two diseases already so named (Paget's cancer of the breast and Paget's disease of the bones) are troublesome enough. It is questionable also, whether a separate name need be given to one type of squamous-cell cancer of the vulva. The squamous cell may undergo many changes in metaplasia, from the anaplastic type of cancer of the pharynx to the fully differentiated adult type of cell characteristic of many squamous-celled cancers; but these are differences in degree and not in kind. The essential fact is that cancers of the vulva are squamous-celled cancers with a potential power to produce metastases soon or later in the regional lymph-nodes. The types that are expansile in their manner of growth and tend to invade the epidermal layer alone may remain localized for long periods; but eventually, they will break through the basement membrane and invade the deeper tissues, and metastases will occur. Such metastases may remain latent for long periods and it is not uncommon to find cancer in the regional inguinal nodes many months or even a few years after the removal of a small lesion from the vulva, which seemed to have little importance at the time of its removal.

Two antecedent histological conditions may have a bearing on subsequent cancer of the vulva. The one, kraurosis, is apparently a trophic condition, characterized by a loss of the glandular and elastic elements, a lessening of the vascular supply and a general atrophy. The epithelium becomes thin and shows no tendency to active proliferation. As a consequence of the trophic changes, small fissures and inflammatory processes occur, from which will result foci of round-cell infiltration and fibrosis. The subsequent cancerous proliferation thus seems due to a secondary irritative process (in a susceptible individual). The second antecedent condition, leucokeratosis, is a frank epithelial hyperplasia from the start and tends to become an invasive process also, under suitable conditions.

In judging the extent of the regional lymph-node distribution for cancer of the vulva, the knowledge gained from the injection of dye-stuffs (Gerota) may be supplemented by the experience of the distribution of the syphilitic inguinal lymph-nodes associated with unilateral initial lesions of the vulva. This lymph-node invasion is uniformly bilateral. It would thus seem logical, in planning operations for cancer of the vulva, to include in the cancer field

(actual and potential), the inguinal lymph-node groups of both sides. On the side of the primary cancer, the lymph-node dissection is carried high into the femoral canal. When cancer has invaded the inguinal nodes to an extent clinically recognizable, the dissection should include the lower nodes of the external iliac group also, access to this field being obtained by dividing the inguinal (Poupart's) ligament.

In the case presented by Doctor Kennedy, an apparently sufficient time has elapsed to indicate an absence of metastasis; but he should feel, nevertheless, that it would be safer (not to say wiser) to remove the regional nodes at least from the tumor side, even at this late date.

TUMOR OF THE SPINAL CORD

Dr. Byron Stookey presented a woman, thirty-eight years old, who had been operated on in 1924 for an extradural spinal cord tumor lying between the second and third thoracic vertebræ on the right side, entirely extradural with a projection which extended forward between the first and second thoracic vertebræ. The spinal cord and dura were pushed sharply to the left. The tumor was encapsulated and was removed. The dura was not opened due to the fact that there was no involvement of the dura. The histological report showed a fibrosarcoma. The patient made a rather slow but an incomplete recovery.

In October, 1925, nine months after her discharge, she was re-admitted with a local recurrence of the extradural fibrosarcoma. At operation digital examination of the dura showed a slight unevenness within and the dura was therefore opened. A fusiform tumor approximately 4 by 1¼ by 1 centimetre was found, entirely free and unattached to the dura and in no wise related to the extradural tumor. The tumor was beneath the arachnoid, was readily removed and appeared to be a glioma. The patient made an uneventful recovery and is now able to do her housework and is entirely well, four and a half years after the operation. X-ray therapy has been given to prevent recurrence of the extradural fibrosarcoma.

When a purely extradural tumor is found without any involvement of the dura the usual procedure is not to open the dura. He presented this patient because of the extreme rarity of finding two tumors of different tissues without any anatomical relation or connection.

FACIAL-HYPOGLOSSAL NERVE CROSSING

Doctor Stookey presented a patient who was operated in 1923 by him at the Post Graduate Hospital for facial nerve paralysis which developed after mastoidectomy. A facial-hypoglossal nerve crossing was done, suturing the distal end of the facial to the proximal end of the hypoglossal and the distal end of the hypoglossal to the proximal end of the descendens hypoglossei.

Volitional control of the facial muscles has returned so that the marked facial asymmetry is now improved so that the face at rest is essentially equal to that of the normal side. The patient is able to move the angle of the mouth and close the eye but is unable to elevate the eyebrow. Emotional responses still show considerable asymmetry but reflex winking has been reëstablished.

Doctor Stookey pointed out that facial-hypoglossal nerve crossing is preferable to facial-spinal accessory nerve crossing since the reflex connections of the facial and hypoglossal nerves are more closely related than the

spinal portions of the accessory nerves which have no reflex connections in common.

DIFFERENTIAL SECTION OF TRIGEMINAL ROOT FOR NEURALGIA

Doctor Stookey presented a patient who had trigeminal neuralgia with primary involvement of the mandibular division, in whom a differential dorsal root section was done in which the sensory fibres of the dorsal root were sectioned without section of the motor fibres or the maxillary or the ophthalmic fibres. Anæsthesia was limited to the distribution of the mandibular division with retention of the corneal reflex and intact motor inervation to the muscles of mastication.

Differential section of the trigeminal dorsal root is the procedure of choice in the treatment of trigeminal neuralgia.

CHOLESTEATOMA

Doctor Stookey presented a woman who was admitted to the Neurological Institute January 3, 1924, complaining of headache, which she had for four years, bad memory, dizziness, failing vision, vomiting and drowsiness. In 1919 for a period of two weeks she remembered distinctly seeing double. Otherwise she had been well. In 1920 she noticed for the first time mild, brief headaches, frontal in type, which occurred about twice a week and which continued until 1922. At one time when she was in the country she noticed a sudden change in her vision. Over night she became nearly blind, the headaches became more severe and she was forced to remain in bed for two days. After that her vision improved but has never been good. Shortly after this she began to have dizzy spells when she had to lie down in order to recover.

In about 1922 her memory began to fail her, she became forgetful, misused words and could not read, claiming that she could not understand what was written. In writing she was also apt to use wrong words. This symptom became progressively worse.

Physical examination in January, 1924, showed gait and coördination to be entirely normal with the exception of a slight tremor in the right hand. Skilled acts were well done. Patient showed an inability to name objects but recognized them and knew their use. There was a marked increase of reflexes on both sides with slight inequality of the abdominals, those of the right side being greater than the left. Fanning was present on the right. Bilateral ankle clonus but no Babinski was found. There was no motor weakness and no spasticity. General sensory examination was entirely negative. The fields, roughly tested, showed marked contraction. The patient was unable to read some printed words but could recognize and name some of the letters. The discs were slightly indistinct, the borders were hazy with some pallor but no swelling.

The X-rays showed evidence of increased intracranial pressure without localization.

January 16, 1924, after raising a bone flap, a ventricle puncture was made. The dura was under pressure. When the ventricle was punctured, the cerebrospinal fluid flowed out drop by drop. Nine cubic centimetres of cerebrospinal fluid were withdrawn and eight cubic centimetres of air introduced. Three days later a needle was inserted in various directions but no resistance was met. Because of the marked tension and inability to reach the ventricle it was deemed unwise to open the dura.

After the patient's discharge she seemed much improved. Her headaches

were better, memory improved but she was very nervous and slept excessively.

Examination in 1926 showed the patient's gait to be normal. She could not swing her right arm. There was very slight awkwardness in the finger to nose test on the right and also in the finger to finger and in the toe to object and heel to knee tests. There was a definite aphasia and anomia. The reflexes were exaggerated, fanning was present on the right but not on the left. Plantar flexion was present on both sides. There was slight spasticity on the right side but none on the left. Abdominals were equal. There was no stereognosis and all sensory findings were normal. Cranial nerves showed a right homonymous hemianopsia with temporal halves of the discs pale. All the other cranial nerves were normal.

December 7, 1926, an attempt was made again to puncture the ventricle and inject air. This was done through one opening of the old osteoplastic flap, using a trigeminal needle which was inserted at a depth of 2 centimetres and a slightly cloudy fluid came out similar to that which was previously withdrawn. It was not considered to be cerebrospinal fluid. Unfortunately the fluid was not centrifuged and studied or the diagnosis would have been made. Ten cubic centimetres of fluid were withdrawn and approximately ten cubic centimetres of air injected and ventriculograms taken. The last two cubic centimetres of fluid removed were crystal clear although the previous eight cubic centimetres were cloudy.

Ventriculograms showed what was apparently a walled-off collection of air on the surface, apparently extracerebral. The conclusion reached was that there was a collection of fluid on the surface, similar to those described by Horax in the posterior fossa which simulated cerebellar tumors—in this case a collection of fluid in the temporal fossa simulating temporal lobe tumor.

At the second operation the old bone flap was re-opened. Just beneath the cortex of the temporal lobe a large cheesy mass was encountered which extended from the region of the mastoid forward beneath the temporal lobe, pushing into the frontal and parietal lobe extending toward the mid-line. When the epidermoid material was finally removed it had occupied an area approximately the size of one's fist. It had a definite capsule and had not eroded the brain at any point. However, the capsule was so soft and friable that removal was impossible. All of the cheesy material was removed, leaving a smooth glistening capsule. This was thoroughly cauterized with Zencker's solution. The tumor mass extended forward underneath the frontal lobe and pushed over the temporal and parietal lobes. The tentorium was exposed behind, the under surface of the temporal lobe and the anterior fossa forward. The dura was closed and the flap replaced.

This has been an extremely instructive case. The patient showed very little progress during the three years between the first and second operations. The problem presented after X-ray therapy was whether the presumed arrest of the growth was due to X-ray or not. Another interesting feature was that a needle inserted through presumably brain tissue may pass through a soft tumor without indicating any resistance; consequently, the absence of resistance to the needle can be met with in the presence of a soft tumor. The third point is that even after the dura is exposed and normal cortex is seen, it does not necessarily follow that the presumed cortex showing through is normal since a whitish-grayish tumor mass such as a dermoid may be present and appear as if it were normal cortex. The dura should always be opened and the wound thoroughly explored.

The patient was discharged January 10, 1927, much improved. There

was essentially no change in so far as aphasia was concerned but the homonymous hemianopsia disappeared.

In the follow-up clinic in May, 1926, the patient was said to have made complete recovery. Her only complaint was forgetfulness. She showed a very slight right hyperreflexia but no pathological reflexes were present. The fundi were normal and the operative area showed no bulging, with the wound well healed. Again in March, 1930, the patient came to the follow-up clinic. Except for occasional headaches and some irritability and anomia the patient seemed well. Muscle joint and tendon sense were normal. Two-point test was normal and touch localization was normal. Cranial nerves were normal.

DR. IRA COHEN said with reference to Doctor Stookey's blaming himself for not having opened the dura at his first operation in his spinal cord tumor case, he did not feel that anyone else would do so. Personally, he felt, that he would have been so relieved to discover the extradural tumor that it would not have occurred to him to look further. Referring to the history of a positive block, the speaker doubted if much stress could be laid on this after a previous laminectomy, because the tumor causes sufficient pressure together with the laminectomy to produce enough adhesions to give block.

DR. IRVING H. PARDEE (by invitation) said that he thought Doctor Stookey had demonstrated the importance of accurate localized diagnosis in these cases and he considered that the case of spinal cord tumor was a striking illustration of this. Charles A. Elsberg, in his book on spinal cord tumors, has stated that he has frequently seen spinal cord tumor in a patient in which one symptom will present itself at a lower bowel and be operated for, no tumor being found; the patient will continue to present symptoms which are later traced to a tumor at a higher level where it would have been found had not the first symptoms led them astray. It is now possible to avoid such errors because the demonstration of a block in the spinal fluid is an indication of a tumor located above such block. Doctor Pardee commented on the fact that through the work of such men as Doctor Stookey and Doctor Frasier, section of the trigeminal root has become a simple procedure. While formerly attended with a high mortality, at the present time death seldom ensues. The operation has become as simple as a laparotomy; it is done under local anæsthesia with the patient sitting in a chair so that there is no danger of bleeding obstructing the field. Differential root section makes it possible to avoid the distressing eye complications which were the result of complete section. As far as intracranial operations are concerned, here is a more serious problem. Laminectomy is readily done and the trigeminal patient is up and about in a few days. The operation of craniotomy is not so serious as is the fact that many of the intracranial tumors are not on the surface but are deeply seated which makes the hazards much greater and results not nearly so satisfactory. Doctor Pardee said he had been deeply impressed with Doctor Stookey's case of suture of the hypoglossal and facial nerve for nothing is more distressing to a person than to have facial paralysis and if by the use of this

operation a fair degree of motion is regained, it is very gratifying and pleasing to be able to accomplish that in these cases.

PULSATING EXOPHTHALMOS

Dr. John M. Hanford read a paper with the above title for which see page 88.

Dr. John M. Wheeler (by invitation) said that most of the diagnoses of this condition have been made by ophthalmologists and the treatment has fallen between ophthalmology and surgery. All surgeons who operate on the neck should give this some study because it is important. It might also we well to practise listening for bruit in fractures of the skull, especially basal fractures. Doctor Hanford had spoken of spontaneous cases but had not emphasized them. Not all the cases are traumatic; the speaker had reported three cases of spontaneous origin, one a man with lues admitted to Bellevue Hospital with non-pulsating exophthalmos on one side and later on a pulsating exophthalmos on the other side. Doctor Burdick operated on him with success. The matter of pulsation of the eye is not of great importance in making a diagnosis although this condition is called pulsating exophthalmos. Simply feeling the globe will not necessarily establish pulsation; the proper way is to press the eye back in its orbit and this will bring out the pulsation beneath the closed lids. Doctor Hanford referred to suturing the eyelids together. The chief dangers to the eye are from hæmorrhagic glaucoma, and loss of vision and probable loss of the eye through injury to the cornea through exposure. Consequently, ordinarily the lids should be held together for resistance to the progressive condition of the exophthalmos and for the protection of the cornea. This requires a refinement of technic so that adhesions can be made which will stay as long as one wishes.

Dr. Daniel B. Kirby (by invitation) said that the part he played in the treatment of this case had been in attempting to relieve the glaucoma. The rise of intra-ocular pressure came from obstruction of the venous system of the eye. In all cases of thrombosis of the central retinal vein, glaucoma is likely to develop and is carefully watched for. In this case, there was interference not only with the central retinal vein, but with all the venous system. The widespread œdema and hæmorrhage blocked the exit of fluids passing from the eye, particularly from Schlemm's canal which has a direct communication with a vein. When it was found that the patient's vision was gone and that the eye was the source of great pain through uncontrollable glaucoma, conservative measures having failed to relieve the tension, there was no other recourse but to enucleate the eye and this was accomplished under local anæsthesia. In regard to the enophthalmos, Doctor Kirby thought Doctor Hanford right in assuming that there had been absorption of orbital fat due to faulty nutrition. In many cases where enucleation is indicated, an implant of various substances is used to replace the globe. This does away with much of the sinking. In this case,

due to her grave condition at the time of the operation, it was not advisable to use the implant. Now that she has recovered, the implantation and plastic repair may be used as an operation of choice. Doctor Kirby said he had reported a case, seven years ago, of a man sixty-four years of age who, thirty-four years previously, had suffered a severe fall and injury to the head. After recovery there was ptosis of the lid on the right side and evidence of injury to the right third, fourth, fifth, sixth, cranial nerves, evidently a lesion in the right middle cranial fossa. The patient died of bronchopneumonia complicating a primary anæmia. Post-mortem examination disclosed a large aneurism 4 by 5 centimetres of the internal carotid artery that had healed by laminated clotting. This case was particularly interesting because it demonstrated that these lesions may heal spontaneously.

DR. GEORGE H. SEMKEN said that several years ago, Dr. Lewellys F. Barker, in an address in the New York Academy of Medicine, emphasized the greater effectiveness of ligation of the internal carotid artery over that of the common carotid in cases of pulsating exophthalmos. He showed the slides of a patient in whom a marked protrusion and pulsation were present. The ligation of the common carotid was effective for about fifteen minutes only, then the pulsation and protrusion reappeared; but both were successfully overcome by an immediate ligation of the internal carotid.

When the common carotid artery is ligated, (1) the immediate collateral circulation comes through the two vertebral arteries and the common carotid artery of the opposite side, by way of the circle of Willis. (2) Soon, however, there is an additional collateral circulation via the external carotid, which has a rich system of communication with its fellow of the opposite side, and (by way of the superior thyroid) with the inferior thyroid branch of the thyrocervical trunk from the subclavian. This collateral supply enters the internal carotid at the bifurcation. (3) In addition to this, there is a further collateral supply via the anastomosing branches of the internal and external carotids. The large amount of blood that enters the internal carotid artery in this way, in the absence of occluding disease in the blood-vessels, tends to reëstablish the high pressure in the internal carotid aneurism, and the objective of the common carotid ligation is not attained.

Since the aneurism is wholly in the territory of the internal carotid, it would seem logical to ligate the internal carotid alone, thereby attacking the main supply vessel directly, minimizing the chance of a major collateral blood supply, and restricting the extent of vascular interference to the minimum. In a patient with pulsating exophthalmos, in whose case I had the opportunity of ligating the internal carotid of the affected side nearly five years ago, there was an immediate cessation of the bruit, a progressive recession of the protrusion and a complete clinical recovery within ten days. This case had been classical and well marked. There had been the history of trauma, a fairly sudden onset of symptoms beginning with engorgement of the blood-vessels of the eyeball, then progressive exophthalmos, and a loud

bruit over the eye, transmitted down the cheek and down the neck, and audible also over both mastoid processes. The veins of the upper lid were distended only when the patient lay in the recumbent posture. There has been no return of any of his symptoms. This experience is in harmony with the favorable results reported in Doctor Hanford's paper for the ligation of the internal carotid.

The ligation of the common carotid has an operative mortality of thirty per cent.; the ill effects being probably due to associated occlusive vascular disease. When the bifurcation of the carotid has been injured in operations for advanced cancer of the neck, it has been necessary to ligate the common carotid, the internal and the external carotid in order to control the bleeding.

In such instances (usually older people), the patients do not regain consciousness and die with the characteristic symptoms of hemiplegia. It is thus evident that the circle of Willis cannot be depended upon alone to maintain the cranial circulation in such circumstances; and that the additional collateral supply between anastomosing vessels of the internal and external carotids is indispensable. This takes place chiefly in two groups—one, the anastomosis of the ophthalmic artery with the angular and the temporal arteries, and the other, the anastomosis of the anterior meningeal branch of the internal carotid with the middle meningeal branch of the internal maxillary artery. These sources of a collateral supply are wholly conserved if the common and the external carotid are undisturbed.

It has been advised, in cases of common or of internal carotid ligation, that the internal jugular vein be ligated at the same time, to prevent too great a lowering of the intracranial blood volume. This has a theoretical merit from a purely physiological point of view, but it would seem objectionable in the cases of intracranial carotid aneurism, where such lowered blood volume and pressure are the objectives sought. It is probably wiser to ligate the internal carotid artery alone, leaving the vein undisturbed.

The technic of ligation of the internal carotid is simple; but as described in the surgical textbooks, it may prove troublesome. The advice usually given is to proceed along the anterior border of the sternocleidomastoid muscle. This carries the dissection into a field of fat, lymphatics and small veins. A more convenient approach may be obtained as follows:

The usual transverse or slightly oblique incision is made with its midpoint over the vessels at a level between the hyoid bone and the upper border of the thyroid cartilage of the larynx. This is deepened through the subcutaneous fat and the platysma. A longitudinal incision is then made in the sheath of the sternocleidomastoid muscle about one-half inch behind the anterior border of the muscle and parallel with it. The muscle is dissected free from the anterior part of the sheath and is retracted, leaving the deep surface of the muscle-sheath as the floor of the wound. Thus, only a single layer of the middle cervical fascia remains as the covering of the great vessels. This fascia is incised longitudinally and the internal jugular vein is recognized, with the thin sheath covering characteristic at this level.

At the anterior border of the internal jugular vein, in this field, a large branch vein is then found—the common trunk of the ranine and the common facial veins. The bifurcation of the carotid usually lies immediately above or below the level of this branch vein, directly anterior to the internal jugular. The space above the branch vein contains fat and some small veins which may prove troublesome. It is preferable, therefore, to approach the bifurcation via the space below the vein junction unless it can be determined that the bifurcation has an unusually high position. Light incision of the fascia then brings the carotid into view; and the necessary extent of exposure is obtained with blunt retractors of Little's type. The relative position of the external and the internal carotid at the bifurcation is respectively anterior and posterior; and they present, with the birfurcation, the appearance of an inverted pair of trousers; but the internal or "posterior" carotid is somewhat larger than the external. The fascial sheath about the arteries is now lightly incised, the opening is lengthened bluntly with a grooved director, and, with the same instrument, the space between the external and internal carotids is cleared. The ligature of chromic catgut No. o is then passed around the internal carotid within its sheath and from behind forward. The internal jugular vein is avoided in this way, and there is no likelihood of including the vagus in the ligature because it lies still further posteriorly, beneath the outer edge of the internal jugular vein. The small "shoe buttoner" type of ligature carrier is advised because there is not sufficient space for the safe use of a Deschamp's carrier. Emphasis must be placed upon the need of care in giving the ligature-carrier its final gentle push around the vessel. It is advanced by a gentle side-to-side motion, which opens the periarterial areolar space. At the end, the instrument should not be pushed forward unless the steel tip of the carrier is clearly visible as such. It has happened that part of the arterial wall, stretched thin, has been carried along on the tip of the instrument, and the final thrust then pushed the tip through the vessel wall.

In the ligation of the internal carotid, other technical points also are of interest. John Collins Warren, in his "Surgical Pathology" showed that after the ligation of a large artery, a partial restoration of continuity in the arterial stream had been established by the development of a collateral vessel that formed a by-pass around the ligated site.

This possibility is obviated by ligating the artery in two places, a few centimetres apart. It is not advisable to divide the artery between these ligatures, since the space is not long enough to provide adequate and safe stumps and the vessel might be pulled away from either ligature. The uncut artery will hold both ligatures well and will also limit the extent of motion possible to each ligature site. It is unwise, however, to leave the vessel segment between the ligatures as a completely closed space in which fluid might collect or in which inflammatory processes might arise that could lead eventually to an ascending thrombosis; so this segment is cut with the scissors through a part of its circumference. Finally, in order to avoid

producing a sudden change in the related intracranial circulation, the first ligature should be tied slowly, with the allowance of a proper interval between the successive stages of the occlusion for the collateral circulation to be established.

<center>STATED MEETING HELD MARCH 26, 1930</center>

<center>The Vice-President, DR. JOHN DOUGLAS, in the Chair</center>

<center>BOWEL CARCINOMA</center>

DR. WINFIELD SCOTT SCHLEY presented seven cases of bowel carcinoma, treated from two to sixteen years ago respectively. They were presented because of the variations of technic employed, two- and three-stage operations having been done, which Doctor Schley believed had placed them in better position for a wide removal of the disease, especially as most of the growths were below the transverse colon, and also because he believed it often wiser to establish a permanent colostomy or sigmoidostomy than to risk viability of the gut in stretching for an anastomosis or trying to create a perineal anus.

CASE I—*Carcinoma of Rectum.* Woman, thirty-seven years of age, was admitted to St. Luke's Hospital December 27, 1924, with a history of bloody diarrhoea with heavy bearing down pains in rectum for six months previously. She had had as many as twelve to fifteen stools a day. On two occasions the blood loss had been considerable. Notwithstanding, she had lost but little weight. She had menstruated regularly. Previous history negative. Parents living and well. Occupation stenographer. She was a rather poorly developed and nourished young woman of fair color. Superficial glands negative. Rest of physical negative with exception of rectum, which showed multiple larger and smaller fairly firm, nodular masses, extending from two centimetres above the sphincter as far as the finger could reach. The larger masses were upon the right lateral wall and anteriorly. They bled easily on palpation. They could be felt through the recto-vaginal septum. Biopsy specimen taken before admission showed carcinoma.

Five days after admission, following 500 cubic centimetres blood transfusion, colostomy was done upon the left side. No palpable glands or intra-abdominal involvement was apparent. The growth had not reached the sigmoid. Three weeks later, excision of the rectum was done by the following technic: With the patient in the lithotomy position, the posterior vaginal wall was incised in the mid-line and incision carried down through perineum and around the sphincter which had been tamponed, painted with iodine and closed with clamps. The incision was then carried down to coccyx. Wide retraction was possible. The vaginal wall was easily reflected and apparently uninvolved. By traction on rectum, it was possible to work widely on the bowel, removing all fat and loose tissue to well above the levators and finally opening Douglas' pouch; after further careful exploration the gut was divided by cautery six centimetres above palpable growth. Peritoneum was closed and the end of the bowel was implanted into the upper part of the vagina. The posterior vaginal wall closed with chromic sutures and perineum with silkworm retention sutures. A tube and gauze drain extended up to gut and were brought out through perineum. Patient stood the one-hour-and-fifty-minute operation well.

Post operatively the drainage was very moderate. Highest temperature

<center>130</center>

101°, with a pulse of 98 on third day. Perineal sutures removed in twelfth day. Drainage tube removed the seventh day. Vaginal douching started fourteenth day and douche returns were at first cloudy and contained mucus, but soon cleared up. Convalescence very uneventful.

Examination of rectum revealed multiple irregular masses, one nine centimetres in length and surrounding the wall except for one centimetre. The fascia at the upper end of the tumor contained three small nodes. Microscopically, the tumor was an adenocarcinoma with infiltration of the muscular coats. Subserosa apparently not invaded nor were the lymph nodes.

It was considered impossible to restore a natural anus at the time as vitiating a wide removal of tumor and greatly jeopardizing the patient's chance of recovery. The colostomy has functioned perfectly and the vaginal mucous discharge is almost nil. She is able to do her daily work perfectly and has remained apparently well for over five years.

It seems noteworthy that a rather rapidly growing and extensive malignancy, in a comparatively young woman, should not have shown greater infiltration and lymphatic involvement.

The two-stage operation without attempt to restore perineal anus contributed much to her recovery.

CASE II.—*Carcinoma of Recto-Sigmoid.* A man, forty-six years of age, well developed and quite well nourished, entered the hospital February 4, 1914, with acute obstruction and marked tympanites which had existed for two days. A history of growing constipation with cramplike pains for the past six months, bowels sometimes remaining closed for a week at a time, and moving with dark blood content, suggested malignant constriction. Rectal examination negative.

Median exploratory the same day showed an annular growth at the recto-sigmoid junction of five or six centimetres in extent. No glands were apparent or palpable and the liver appeared free of metastases. A left-sided colostomy was done the same day. Three weeks later the growth was resected with all of the mesentery and some six inches of uninvolved gut. End-to-end suture was done. A tube previously passed through to rectum was used by traction to invaginate the upper an inch into lower half and held by chromic sutures interrupted—a rubber dam cigarette type drain inserted to line of union. Except for slight leakage on the third day, which lasted for a week only, convalescense was uninterrupted. Highest temperature 101 1-5 with a pulse of 82.

Examination showed an annular constricting neoplasm reducing gut lumen to four millimetres. The growth had actively invaded and extended entirely through the gut wall and the small glands in the meso-colon were invaded. Surface of tumor presenting in gut showed marked necrosis and ulceration. Type, Adenocarcinoma. No gelatinous changes. Colostomy closure done by clamps.

The patient was fortunate in having an obstruction call attention to his carcinoma before inoperability occurred.

The two- or three-stage operation in the presence of obstruction still seems to me desirable. A wide removal of gut and mesentery was done. The patient remains well over sixteen years following operation.

CASE III.—*Carcinoma of Recto-Sigmoid.* A stout woman of fifty-six years of age, admitted August 21, 1922, for some months had been having cramping pains and distension with expulsion of large amounts of gas by mouth and rectum following these attacks. Cathartics and enemas would bring away hard fæcal material.

On entrance, obstruction was subacute with tympanites.

In view of the increasing constipation with tympanites, a diagnosis of malignant growth obstruction of the large gut, sigmoid or recto-sigmoid, was made. Rectal examination revealed nothing.

Five days later, median incision under gas-oxygen showed recto-sigmoid growth and a *left side colostomy was done.* Mesentery, glands and liver appeared free.

Four weeks later, wide resection with removal of mesentery was done. Anastomosis, because of extreme fat, difficulty and danger in mobilizing gut and general condition of patient, was not done at this time. Rectal end of sigmoid closed and proximal end left open in colostomy wound, its upper opening preventing exclusion. Rubber dam cigarette drain to pelvis.

Examination showed an extensive adenocarcinoma of the recto-sigmoid narrowing and infiltrating gut, with a polypoid tumor additionally obstructing the lumen. Submucosa and muscle invaded but mesenteric nodes not.

This patient, after leaving hospital, showed marked arterial hypertension, blood-pressure of 240/260, traces of albumin and sugar and was not considered a good risk for further operation to anastomose the bowel. She has gone on seven and one-half years with her colostomy very satisfactorily.

Some six months ago apparent recurrence had taken place in the blind sigmoid end, but after washing out hardened faecal matter, bleeding ceased and she has been well since.

The operation may be considered incomplete but the patient has done well with her colostomy which does not seem a heavy price to pay for her recovery.

CASE IV.—*Carcinoma of Cæcum.* A poorly nourished anæmic man of fifty-six years of age was admitted to the hospital January 31, 1918, having lost nearly forty pounds in weight in the last year. His chief complaints: Loss of strength and weight with the presence of a large movable mass in the right lower quadrant of the abdomen. There was a marked anæmia. Patient said he had not noticed blood in stools and had had no diarrhœa. He was given blood transfusion and a two-stage operation was done: First an ileo-colonic anastomosis between the lower ileum and the transverse colon. Second, three weeks later with the patient in greatly improved condition, a removal of the lower ileum, its mesentery and glands, the cæcum and ascending colon up to hepatic flexure.

Pathological examination revealed a large cauliflower mass eight by seven centimetres within the cæcum almost obliterating the lumen. The lymph nodes along the terminal ileum were much enlarged and were involved. The appendix, twelve by one and one-half centimetres, showed beginning involvement.

Diagnosis.—Gelatinous carcinoma of the cæcum.

The convalescence was smooth and progressive. highest temperature 102 1-5 with pulse of 110 the day after the second operation.

The two-stage operation was the deciding factor in this man's recovery, permitting more radical and less complicated work in the second stage. He has remained well for twelve years.

CASE V.—*Inoperable Carcinoma of Rectum.* A well-developed and still well-nourished man, moderately anæmic, who had lost some thirty pounds in weight and suffered for three months with bloody stools and passing blood from rectum with very constant desire to defecate, was admitted to the hospital September 16, 1927. Examination showed extensive masses with complete annular narrowing four centimetres above sphincter and extending up to eight to ten centimetres above sphincter. Considerable fixation was present with apparent infiltration of prostate and bladder fascia.

A colostomy through right rectus, which was expected to be permanent, was done. Biopsy showed adenocarcinoma of rectum. This man was examined by several members of the staff, who concurred in the opinion of inoperability. Accordingly he was subjected to radium treatment—using 100 to 150 milligrams radium element made up as application extending full length of growth. Many shorter treatments were given, rather than massive or large doses. Treatments were given at intervals over a period of several months. Improvement was continuous. This man has since had three proctoscopic examinations under general anæsthesia, showing the disease apparently cured. Mucous membrane smooth, glazed in appearance, yellowish pink in color.

A year and one-half after his first treatment he begged a closure of his colostomy as he feared he would be unable to work with it. X-ray examinations of chest, abdomen and bones were negative for metastases. Closure was therefore done with misgivings. He has remained apparently well. The last proctoscopic was done February 4 of this year. Other than large calibre stricturing from the fibrosis, with the mentioned changes in mucosa, nothing was to be seen.

This patient is not presented as cured as the time is still short for such assertion. That such an extensive growth should have shown the disappearance it has is, however, noteworthy.

Cessation of pain and bleeding is of frequent note in radiation treatment with prolongation of life even for several years. Ray sensitive growths may be cured. His treatment started October 26, 1927.

November 21.—Bleeding ceased and a gain in weight and color was very noticeable.

December 12.—Masses considerably reduced; more movable.

January 12.—Marked improvement, masses nearly flat, prostatic and bladder areas now the worst.

March 7.—Patient looked even ruddy. Rectal masses small, flat and firm. No treatment since May 16, 1928. He had a total of 2650 miligrams hours in thirteen treatments.

CASE VI.—*Gangrenous Diverticulum of Rectum and Sigmoid.* A stout, acutely ill woman of forty-seven years of age, with abdominal distention and rigidity of left lower quadrant and mid-line below umbilicus, was admitted to the hospital May 26, 1916. Pain had begun over lower abdomen three days before admission and was made worse by castor oil taken the morning of admission when she was nauseated and vomited for the first time. There had been no diarrhœa or excess mucus noticed in movements. A sense of discomfort in lower abdomen preceded the attack. Frequent urination without hæmaturia was present. No blood had been passed by rectum. She had had a similar and a milder attack several months before with fever. Digital, rectal and vaginal examinations were painful higher up with sense of mass. Patient had menstruated a week before.

Operation second day after admission showed perforation of a diverticulum of the sigmoid just above the rectum into its mesentery with marked inflammatory reaction of all coats of gut and mesentery. Lower sigmoid and upper rectum gangrenous for three to four inches with free pus in pelvis. The condition of the gut, it was felt, forced resection upon us with the risk of opening up fascial planes. The sigmoid was cut across with cautery well above the involvement and gangrenous sigmoid and rectum resected with mesentery. *Distal end* closed by double chromic gut inversion and proximal end brought out as colostomy through left rectus.

Except for moderate temperature elevations on fourth and fifth days,

moderate abdominal distention, convalescence progressed satisfactorily. Patient out of bed on twenty-second post-operative day.

Several times, in the year following her operation, anastomosing the bowel was considered, but X-ray barium plates showed so wide a gap, that even the chance of mobilizing the sigmoid was considered inadvisable, as she was doing so well with her colostomy and did not, herself, care to assume too great risk.

She has remained well nearly fourteen years.

CASE VII.—*Carcinoma of Neck. Reported as Metastatic in Lymph Node.* A woman fifty-one years of age, was admitted to the hospital September, 1922, well nourished and of good color with a rather firm mass, the size of a hen's egg, in the left side of her neck anterior to sternomastoid, movable on deeper structures but attached to surroundings. Mass appeared three months previously as a small, firm, non-tender nodule well under the skin. No other masses or glands palpable. Past history negative for tuberculosis and negative except for abscessed teeth fifteen years before. Family history negative for tuberculosis or malignant disease. A careful physical, before operation, including nose, throat, pharynx, œsophagus, thyroid, vagina and rectum, revealed nothing abnormal nor has anything appeared in the seven and one-half years since operation. A provisional diagnosis of growth arising from brachiogenetic cleft was made; probably malignant from the feeling, complete absence of subjective or objective inflammatory signs or history.

A transverse incision revealed a tumor some six by three by three centimetres, quite definitely encapsulated, attached to carotid sheath. The upper extremity was less definitely encapsulated and there were attached a number of fibrous tissue clusters resembling very small grapes. No enlargement of cervical or superficial nodes could be demonstrated.

Microscopically, the larger portion of the mass was composed of solid carcinomatous growth, the nuclei of the cells of the tumor were large, vesicular, irregular and mitoses were extremely numerous. Sections also showed portion of a *lymph node at the periphery of the mass* and indicating that the latter was a *metastatic growth* invading the node. The source of the growth could not be stated. It seemed unwise and useless therefore, to do an extensive neck dissection. The noteworthy features seem to be: The rapid growth with intact capsule, lack of infiltration and apparent absence of other glands or masses; the apparent metastatic character of the growth and inability to demonstrate a primary source in seven and one-half years.

To what extent can the microscope be relied upon as a gauge of clinical malignancy?

The patient had one deep therapy X-ray treatment before leaving the hospital, where she remained but eight days following operation.

DR. FREDERIC W. BANCROFT asked Dr. Schley how his patients managed their colostomies. Frequently in his own experience he had found that patients gave up the cumbersome colostomy cups and invented methods of their own which were satisfactory.

In one case that Doctor Schley has reported he suggested reoperating and uniting the colostomy with the distal segment. Harvey Stone, of Baltimore, experimenting in dogs, had taken a loop of ileum, transposed it between the two ends of the bowel and made an end-to-end anastomosis of the proximal and distal portions of the ileum, from which the loop had been removed. In these cases he has had very satisfactory functional and radiographical results. Recently Stone has reported this procedure in a human case, with a resultant satisfactorily functioning lower bowel.

DR. CARL EGGERS commented on the fact that the entire subject of infection of the sigmoid is very little understood. As a matter of fact the condition is more common than is generally believed. A number of cases of that type have come under the care of Doctor Eggers, some forming very large tumors so that he was loath to believe they were merely inflammation of the sigmoid. One such case was referred to him with the diagnosis of twisted ovarian cyst, but eventually the correct diagnosis of sigmoiditis was made. The most interesting thing about the condition is the etiology. In this case, although running an elevation of temperature to 104° and with a high pulse rate, all cultures were constantly negative, the blood count was 30,000, and polynuclears 85 to 90 per cent. Some of these cases clear up without treatment and some perforate. One man diagnosed as carcinoma of the sigmoid was operated on by another surgeon last summer; he found a large sigmoid with inflamed walls. After dividing many bands of adhesions he let him alone. Recently the tenderness increased, temperature rose to 104°, the blood count became high, and as conservative treatment was started there was perforation into the adhesions from the former operation, after which it was easy to drain this abscess. He eventually succumbed. If this condition can be surgically handled, resection may at times be the procedure of choice. Doctor Eggers refered to a case now under his care operated on by Doctor Kammerer twenty years ago. Doctor Kammerer was under the impression he was dealing with a carcinoma and did a resection with a permanent colostomy. Doctor Eggers explained how this patient takes care of it. She moves about in society and has long lost any timidity. She has never used a bag. She applies a little zinc oxide in castor or olive oil, forming a paste, around the colostomy opening, places a small rosette of gauze in position around the colostomy and covers all with paper napkins held with a binder. After an accident, the entire dressing can be picked up and thrown away, and is easily replaced. There is at no time any odor about the patient. This simple dressing is being used in several other cases with excellent result. In case the bowels become loose as the result of ingestion of fruit, a powder containing a little powdered opium is given for a day or two.

DR. WALTER M. BRICKNER said that actinomycosis should be borne in mind as an occasional cause of massive sigmoiditis. Actinomycoses sometimes subside spontaneously in the bowel even while spreading elsewhere, which would explain recoveries in sigmoiditis with no other factor. Actinomycosis of the sigmoid is apt to be mistaken grossly for carcinoma or, sometimes, for diverticulitis. It should be remembered, too, that in actinomycosis there may be long periods when neither granules nor mycelia can be found in the pus.

DOCTOR SCHLEY, in closing, replied to Doctor Bancroft that these patients seemed to have no trouble at all in handling the colostomy opening. The bag is merely a rubber ring and pouch held in place with a minimum amount

of pressure. As to the bowel movements, most of these patients have less constipation than before operation and daily enemas are not necessary. Several have to be careful with fruits and laxatives and a little mineral oil or milk of magnesia is usually sufficient when occasionally costive. In the case referred to by Doctor Bancroft, the reason Doctor Schley did not try to accomplish further union was because so much of the gut had been necessarily removed that there was a great probability of disturbed viability of the sigmoid in trying to bring it down. A permanent colostomy seemed not a heavy price to pay for much greater assurance of cure—and these bad cases have remained cured.

HARELIP AND CLEFT PALATE. AN ANALYSIS OF 184 CASES

DOCTOR CARL G. BURDICK read a paper with the above title for which see page 35.

Doctor Burdick presented a number of cases illustrating his paper. The first group represented the incomplete clefts of the lip both single and double, most of which were converted into complete inasmuch as the tissue above the cleft was abnormal and had to be excised to obtain a satisfactory cosmetic result.

The second group comprised cases of complete cleft of the lip, alveolus and palate. In the majority of these the alveolus was moulded and wired at an early age to restore the normal curve of the alveolar arch and the lip repaired at the same sitting. Several operations were necessary to successfully close the palate in practically all these patients and a few complete failures were included. Three patients were presented in whom the lip was much flattened and contracted and this deformity was improved by taking a V-shaped piece from the lower lip and transplanting it into the upper lip.

In the fourth group several children and adults with complete and incomplete clefts of the palate which had been successfully repaired were presented to demonstrate the improvement in speech after attending a school for speech correction.

The last group included children which had recently been operated upon. A brother and sister with incomplete clefts required three operations before complete closure had been obtained and in two other children the repair was only partially successful after one or more operations.

DOCTOR FRANK S. MATHEWS said: A few years ago there had crept into the medical mind a great deal of difference of opinion as to how to handle these cases. There was scarcely any agreement as to operative methods or time of operating. The methods recommended by Doctor Burdick, however, seem to be those upon which the operators of today have pretty well agreed. For the average case, the Langenbeck repair of the palate with rather moderate variations in detail has replaced other methods. Furthermore the tendency seems to be, in repairing the lip, first, to construct the nostril accurately and then close the lip after a simple denudation: this same method

replacing the numerous methods of cheiloplasty based on complicated denudation patterns. Emphasis should be first given to the restoration of the alveolar margin with the idea that restoration of function should be kept prominently in mind. If the jaw is not restored so that chewing is possible, growth of the jaws—chiefly the upper—is seriously interfered with. A chief defect, not usually mentioned, of the Brophy method is that the sudden narrowing of the entire cleft also immediately narrows the nasal cavities, establishing mouth breathing which may be permanent.

Surgeons are much handicapped in many of the cases by deficiency of tissue. Sometimes we are simply dealing with a cleft in tissues of fairly normal quantity, but there is every degree of deficiency. Brophy claimed the opposite, namely, that the amount of tissue is normal.

Doctor Mathews believes that in the future there is room for advance in handling these cases, in deciding whether tissue is adequate to make a functional palate with ability to close off the nasopharynx, or whether we had better admit defeat in advance of a failure and turn more of these cases over to the dentists for treatment by diaphragms. I doubt whether as much will be accomplished in any adult by operation in improving speech as can be gained from an appliance by an expert.

The great objection to the appliance treatment is the expense, whereas surgeons can always be found to operate gratis. The financial difficulty appears also when one considers expert speech training. His experience is that it is usually difficult to obtain. In most cases we have to rely on the parent alone. His advice to each mother is, first, no "baby talk," second, train the child to speak slowly, and third, exercise the palate muscles by the use of toys which require blowing and whistling.

As the speaker has shown, nothing has such a good effect on the alveolus and the entire length of the cleft in the palate as the restoration of the lip. Several times Doctor Mathews has closed the lip in the second twenty-four hours of life before the baby has lost weight and nutrition. Doctor Burdick has advised postponing the palate closure to a rather later period than has been his custom. One of the great difficulties which all encounter in recommending postponement of operation is the insistence of the parents on having the operation as early as possible. Personally, he has seen no objection to operating in the second year. It had seemed to him particularly difficult to get a good result on a double complete harelip and this he had attributed to a deficiency of tissue. If one uses all the lip available and makes the two lips meet below the prolabium one may get a long lip from above downward but so tight that it presses the teeth backward. This difficulty probably accounts for the recommendation which Brown and others have made of suturing each lip to the sides of the prolabium, thus producing a sufficiently broad lip at the expense of shortness with the necessary exposure of the incisor teeth. In a few cases of double cleft lip the speaker had thought it advisable to divide the operation into two, at the first replacing the premaxilla, restoring one nostril and suturing one lip to the prolabium; the second operation

restoring the other nostril and completing the lip operation. The Lane method had been tried by him a few times with some anatomical success but no success with regard to speech. Lane is to be credited with stimulating an interest in the entire subject but not with an advance in our operative methods.

The mortality of these cases is fortunately high, the hereditary element in its etiology being conspicuously prominent; and, if the inheritance is a Mendelian recessive, the damaged germ plasm will be inherited through an indefinite number of generations to appear when it is found in both parents.

Surgeons operate with the idea of improving the lot of these afflicted individuals. But it is certainly to the advantage of the race, that they should not reproduce their kind; and this is why he said that it is no misfortune that so many die in infancy with or without surgical treatment.

He had never used metallic plates to take the strain off the suture line. He doubted whether he made as long lateral incisions as some operators. Instead he had followed a suggestion of Dowd's and had packed the lateral incisions firmly with iodoform gauze to force the flaps inward. Sometimes the gauze comes out of itself and at other times he had removed it after several days.

It did him good to hear Doctor Burdick's table of operative results where among many favorable operative results he had to record so many multiple operations, for he also had had many unfavorable results. His results in palate work, so far as speech is concerned, had been distinctly unsatisfactory.

When one considers the variety in the extent of the deformity and the age of the patient one realizes that each case presents somewhat different problems. It is for this reason, among others, that he believed this work should be turned over to surgeons whose medical connections are such that they can get a good many cases. If the cases are to be distributed among all good surgeons no one will get enough to ever become expert at this work. Furthermore, some very good surgeons are temperamentally not suited to doing such good harelip and cleft palate work.

Doctor Henry Sage Dunning (by invitation) said that there are several things to keep in mind at the time of operation. If one operates and closes the lip in ten days the baby does not stand the operation as well as if it were done at the age of six weeks. If it is an anterior bony cleft this must be closed within three weeks if possible. When it is a cleft of the palate itself, it is the general opinion that it should be closed later, at about the third or fourth year. It.is improbable that this interferes with the child's learning to talk; at any rate, this is not the important factor. There is a very strong feeling prevalent that the Brophy operation is not to be used except in rare cases. It is a difficult operation for most men to perform even though they are skillful in palate surgery and the results do not justify the operation. It is wiser to close the anterior cleft by premaxillary wiring after moulding the bones, but one must be very careful not to overdo even this. It would

appear that the general tendency is to get away from the procedure of wiring the bones as much as possible. The speaker did not place any value on the Lane operation whatever, except in the rarest of cases. The scissors flap operation, that is, bringing one flap over another and closing half the palate at a time, will do as much as the Lane operation can possibly do. Iodoform gauze packing on either side of the long lateral incisions is very important and takes the place of the complicated silver bands or other devices. As to the ribbons described by Doctor Burdick, Doctor Dunning did not think they were necessary. Regarding the mortality figures in the paper of the evening, this is difficult to explain but the answer probably lies in the fact that these should be pædiatric cases before and after operation, and should be carefully worked up, and none of the patients should be kept on the table for more than one hour for any reason whatever. If the lip breaks down it is probably due to infection or improper tension and this is a calamity that ought not to happen very often. There is generally a definite reason for it. Doctor Dunning believed that this work should be done by men who are especially trained to do it and that it is very difficult and unsatisfactory work at best.

DOCTOR DOUGLAS B. PARKER (by invitation) approved of Doctor Burdick's operation on the nares. Many of those cases usually seen had post-operative flattened alæ, but Doctor Burdick's cases have well-formed alæ, and good fullness, which is still better. The speaker called attention to one phase of the work in bilateral cases, viz., the saving of the premaxilla. It is often distressing to discover that the premaxillary bone has been lost in these flattened lips with no base of support for nose or nares, making it difficult to do proper plastic work. So many have had a V-shaped piece taken out and the premaxillary tilted back; the result is not functionally correct. A quadrilateral incision as advocated by Doctor Burdick is better. In regard to the lateral incision, most operators do not continue it back far enough; it is usually too small. In doing these cases to get greater function-ability of the palatal velar, it is often necessary to relieve the tension there. Doctor Burdick had not mentioned that except in reference to the operation of Dorrance. In regard to the mortality rate, this was surprisingly high. Too much emphasis cannot be placed on the fact that these children should receive especial care in preparing them for operation. These infants are primarily feeding cases and no operation should be done until the pædiatrist is satisfied that no infection is present and post-operative by the child should be placed in the hands of the pædiatrist again. Where this has been done the results have justified the procedures. In his mortality cases of cleft palate, Doctor Burdick reported that the temperature went up very high, 106° to 108° and a number died within twenty-four hours after operation. It is possible, as he said, that aspiration of blood may have played a part although it was doubtful if this were often true in so short a time. It might have been so in the later pneumonia cases. The selection of the proper time for the

operation means much, but the avoidance of traumatization of tissues means more. In the hands of the general surgeon the operation is not often warranted; the results are poor and the mortality rate is high. In the hands of the specialist these results can be improved.

DOCTOR BURDICK, in closing the discussion, said that patients requiring training in speech correction had been referred to the National Hospital for Speech Disorders. He considered this an excellent institution and the authorities had been most willing to receive patients who could pay little or nothing. He congratulated Doctors Dunning and Parker on their splendid record of three hundred operations without a death and regretted that the mortality in his own series had been so high. Of course it was essential to exercise the utmost care in selecting the most favorable time to operate. Bellevue Hospital has an excellent pædiatric service which coöperates perfectly satisfactorily with the children's surgical service and he felt that the responsibility of the deaths was directly up to the surgeon and could not reflect in any way on the lack of attention on the part of the pædiatrician either before or after operation. While the sentiment of all the gentlemen discussing the paper seemed to be against the use of the metal bands, Doctor Burdick believed that his results were much better since employing them. He was glad of such a unanimity of opinion on the methods of Brophy and Lane and that all were in favor of Langenbeck's operation.

BRIEF COMMUNICATIONS

CHANGES IN THE HUMAN INTRAHEPATIC BILE DUCTS FOLLOWING CHRONIC CHOLECYSTITIS, CHOLELITHIASIS AND CHOLECYSTECTOMY

IN A previous communication, ANNALS OF SURGERY, vol. xci, pp. 65-72, 1930, it was shown that certain changes occur in the intrahepatic bile duct epithelium of dogs following cholecystectomy. The normal intrahepatic ducts are lined with a smooth layer of simple cuboidal epithelium and as early as fifteen days after the removal of the gall-bladder there is a distinct

A   B

FIG. 1.—A. Mucous fold of a dog's normal gall-bladder. B. Tip of an intrahepatic duct fold seventy-seven days following cholecystectomy (dog).

alteration of the morphology and the arrangement of these cells. The epithelial surface is irregular and large cells project into the lumen of the ducts. These changes were studied in sequence and it was found that mucous folds and villi develop in the intrahepatic ducts and that high columnar cells cover these projections. Seventy-seven days following cholecystectomy these folds and villi (Fig. 1B) are histologically identical to the mucous folds of the normal dog's gall-bladder (Fig. 1A). Ligation of the common bile duct

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after cholecystectomy or with the gall-bladder intact results in enormous dilatation of the duct system; the epithelium becomes flattened and after death from such obstruction the bile ducts can be identified in sections only by their size; the epithelium has disintegrated and there are no projections into the duct lumina. From this evidence it appears that fo'lowing cholecystectomy the intrahepatic bile duct epithelium becomes altered in order to assume functions normally performed by the gall-bladder.

In the human liver the smaller intrahepatic ducts are lined by simple low cuboidal epithelial cells which present a uniform smooth surface. As these

FIG 2 —Normal human intrahepatic duct near the porta hepatis (human)

ducts are traced towards the porta hepatis it is seen that they increase in size and that the epithelium gradually becomes columnar. (Fig. 2.) At the junction of the intrahepatic and the extrahepatic ducts there is a sharp transition in the height of the cells and the ducts outside of the liver are lined with high columnar cells. In all locations in the intrahepatic ducts the epithelium normally maintains its simple arrangement and the surfaces of the ducts are smooth.

In chronic cholecystitis we have the development of excessive amounts of fibrous or scar tissue in the gall-bladder wall and alteration of its mucous membrane and submucosa. The normal functions of the gall-bladder cannot be performed under these conditions and we have *a functional cholecystectomy.*

With this premise in mind fifty routine liver sections obtained at autopsy were examined. In these subjects there was well-developed chronic cholecysti-

tis, cholelithiasis or the gall-bladder had been removed at a previous date for chronic cholecystitis or for cholelithiasis. The following examples are cited to show that following functional destruction of the human gall-bladder changes occur in the intrahepatic ducts which are similar to those found in the dogs following cholecystectomy.

A small intrahepatic duct in a section taken from a liver with a shrunken fibrotic gall-bladder (Fig. 3) shows two well-developed projections in the lumen which are covered with high columnar cells while the duct wall opposite to them is covered with low epithelial cells. The longitudinal section of a
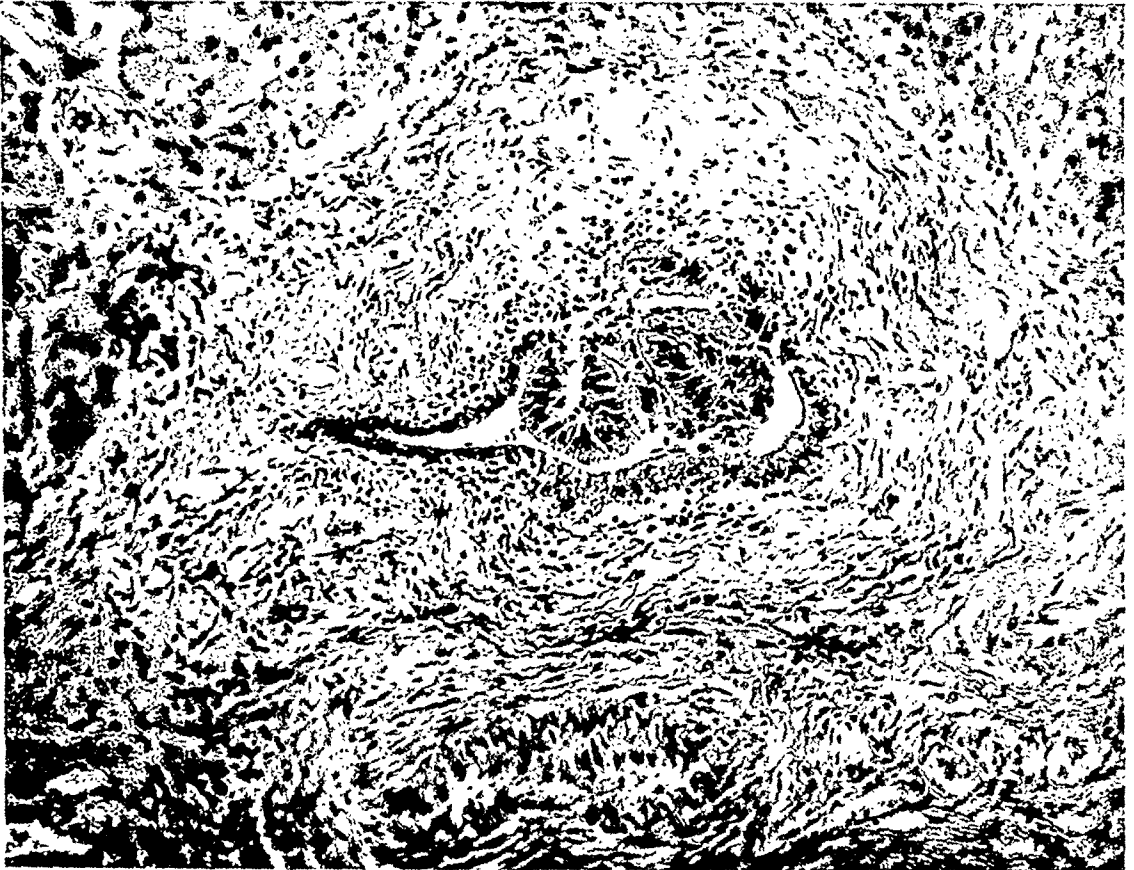

Fig. 3.—Small intrahepatic duct showing two projections covered with high columnar cells. Chronic cholecystitis with small fibrotic gall-bladder. No. 28-238 McManes Laboratory of Pathology, University of Pennsylvania.

small duct (Fig. 4) shows small projections in the lumen. A cholecystectomy had been performed but the date of the operation was not given in the autopsy protocol. Common duct stones, dilatation of the common duct and stones in the gall-bladder are accompanied by the changes shown in Fig. 5. Specimen 00-44 showed common duct stones, a fibrotic gall-bladder the thickness of a thumb, portal cirrhosis, and a dilated common duct. A section of an intrahepatic duct near the porta hepatis (Fig. 6) shows well-developed folds. The existence of well-developed mucous folds and projections in an intrahepatic duct is shown in Fig. 7. In this subject the gall-bladder was dilated, its wall was thin and fibrotic and it contained 500 cubic centimeters of thick yellow bile and four irregular rough black stones. The ducts were all patent and pressure upon the gall-bladder forced bile into the duodenum.
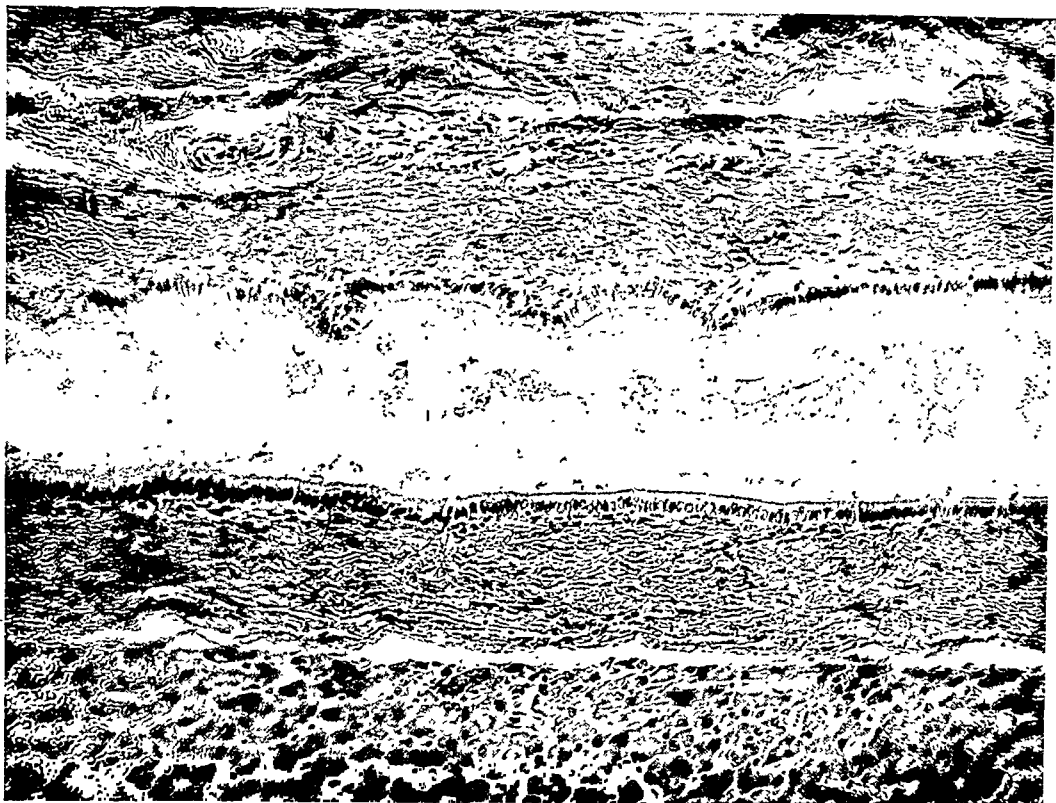
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FIG. 4.—Longitudinal section of a small intrahepatic duct showing small projections. Cholecystectomy. Date not stated. No. 4158 13-49. McManes Laboratory of Pathology, University of Pennsylvania.

FIG. 5.—Duct near the porta hepatis showing well developed small projection. Chronic cholecystitis with stones; common duct stone with dilatation of the common duct. No. 4016 12-120 McManes Laboratory of Pathology, University of Pennsylvania.

FIG. 6.—Duct near the porta hepatis showing definite mucous folds Gall-bladder scarred and the thickness of a thumb; cholelithiasis; dilation of the common duct; portal cirrhosis. No. 00-44. McManes Laboratory of Pathology, University of Pennsylvania.

FIG 7.—Intrahepatic duct showing many well developed folds and globules in the periphery of many cells similar to those often found in normal gall bladder epithelium Gall bladder dilated, wall thin and fibrotic, contained 500 cubic centimetres thick yellow bile and four stones. No. 29-728. McManes Laboratory of Pathology, University of Pennsylvania.

An examination of these sections shows that the tunica propria of the mucosa does not enter the projecting folds and that each possesses its own fine stroma. This is convincing evidence that these projections in the lumina of the intrahepatic ducts are true mucous folds and not artefacts produced by contraction and infolding of the duct walls during fixation. Comparison of these folds with those found in a normal human gall-bladder (Fig. 8) shows a striking resemblance. Some of the cells in the duct folds (Fig. 7) show globules, especially at the tips of some of the projections, which are characteristic of the normal gall-bladder cells.

Portal cirrhosis and metastatic carcinoma of the liver, when not accom-

Fig. 8.—Normal mucous folds of a human gall-bladder. From "Chronic Cholecystitis without Stone." Frederic W. Bancroft. ANNALS OF SURGERY, November, 1923.

panied by chronic cholecystitis, cholelithiasis or cholecystectomy, do not produce these changes in the intrahepatic bile duct epithelium. The changes seem to be due to the destruction of the function of the gall-bladder and the duct epithelium undergoes alteration in order to assume functions normally performed by the gall-bladder.

SUMMARY

1. Definite changes occur in the dog's intrahepatic bile duct epithelium following cholecystectomy which may compensate for the loss of the gall-bladder.

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2. In human beings chronic cholecystitis, with or without gall-stones, results in *a functional cholecystectomy*.

3. Cholecystectomy, whether functional or operative, is followed in the human intrahepatic bile ducts by the production of mucous folds and villi similar to those found in the normal gall-bladder.

4. The intrahepatic bile ducts in man and dogs appear to adapt themselves to perform functions of the gall-bladder following its destruction.

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IMMOBILIZATION BY STEEL SKEWERS IN FRACTURE WITH CONSIDERABLE LOSS OF BONE AND DESTRUCTION OF SOFT TISSUES.

C. C., an American, forty-eight years of age, was admitted to the Clearfield Hospital, February 8, 1928, at 1:30 P.M. About two and one-half hours previous to admission he had been hit by a bullet fired from a second-story window, a distance of thirty-five or forty feet, the bullet striking the patient's right arm just below the deltoid attachment, comminuting and shattering about five inches of bone, lacerating and dividing nearly all the soft tissues except the brachial artery, vein, and brachial plexus. The wound of entrance upon the anterior lateral surface of the arm was about the size of a silver dollar. The wound of exit upon the posterior medial aspect was the size of the whole hand; the pumpkin ball, which had been the type of bullet used, then tore into the muscle of the lateral surface of his flank and abdomen from the twelfth rib downward and was removed six inches below at the level of the iliac crest.

The wound of entrance and the large gaping ragged wound of exit were examined. Débridement of devitalized skin and muscle was done and entirely detached spicules of bone were removed. About two inches of the continuity of the bone at the musculospiral groove and two inches of the musculospiral nerve were missing.

The man had been engaged in shoveling manure at the time he received the wound. His clothes were badly soiled. Much of the soiled clothing had been carried into the wound as the explosion and tearing force of the large soft pumpkin ball was terrific when it shattered the bone. These two factors, the character of the wound and the great amount of contamination, stimulated us to do a thorough débridement and when finished, to be skeptical of the completeness of our efforts so that all thought of plating the bone or suturing of the wound was decided against. Hence, the following procedures were carried out: After the preliminary débridement, as above detailed, the intact part of muscles was tunneled, the torn ends of the musculospiral nerve were cut across above and below the area of evident gross traumatism with a sharp knife, twisting being avoided. They were then lightly sutured together, the ends being approximated. This approximation was possible because of the change in the course of the nerve, its bed being changed to the muscle tunnel anteriorly. This procedure was done not only to gain slack but also to take the nerve away from the area where callus would form. Part of the slack was obtained by the shortening of the arm due to the loss of bone. The maintenance of contour and the holding of fragments of bone in alignment were very well accomplished by the employment of "skewers." For this we used Wyeth hip-joint amputation pins. They were made to serve in the following

manner: A stab incision was made to the bone, high near the shoulder-joint, external and posterior. The pin was made to follow the bone until the point appeared in the wound and the point was guided across the gap of the wound and made to enter the distal side, grazing the bone all the way, until the point emerged just above the olecranon. A sterile cork was then used to cap the point. As one skewer did not give sufficient stability another was introduced in a similar manner antero-medially. The action of these skewers was very satisfactory. Introduction was quickly accomplished with no disturbance of bone as would have been the case with an attempted bone plating.

FIG. 1.—Use of steel skewers to immobilize gunshot fracture of humerus with much loss of tissue. Rontgenogram taken fifteen days after injury.

FIG. 2.—Case shown in Fig. 1 seventy-three days after injury. Note the particles of lead throughout the callus.

With some sheets of nickel alloy a molded splint was made that encompassed the arm through nearly half of its circumference, and was held in place with adhesive straps. The whole arm and forearm was then placed in an angular Thomas arm splint. The whole was suspended above the level of the body in order to prevent œdema. Great care was used that there were no constricting bandages nor adhesive strips. The wound in the arm was lightly packed with acriflavine gauze. The wound at the side of the body was freed from foreign matter and devitalized tissue; a counter opening was made over the bullet which could be palpated in front of the iliac crest near the anterior

, superior spine. The bullet, which was found to have been flattened, was removed. Through and through acriflavine gauze drainage was placed. After the patient had recovered from the anæsthesia, 1500 units of antitetanic serum were given intramuscularly and later bacillus perfringens antitoxin.

The after-progress was unattended by any unfavorable incidents. By February 29 the wound had granulated and the skewer pins were removed. A molded nickel coaptation splint was applied, also an anterior and posterior plaster-of-Paris splint from the shoulder to below the wrist. A large window was left corresponding to the still open . wound on the lateral surface of the arm. This area, in the course of treatment, was dressed with Beck's adhesive strapping and painted with mercurochrome. Hot air current was periodically applied. Dressings were continued until March 23, when the patient was allowed to go home. At the time of his discharge there seemed to be a rather abundant callus which was not as yet rigid.

The patient returned for inspection April 21. Check-up X-ray showed large callus and considerable lead through the tissues. May 19, check up showed the same result but callus much denser. Upon examination in March, 1929, a year and a month following the operation, I found an arm about one inch to one and one-half inches shorter, much scarred but in every other way a perfectly normal arm—good strong bony union, good muscular strength, no wrist drop, no loss of sensation or motor ability. The patient stated that he had been working hard and having no difficulty at all.

This case is reported because of the use of skewers instead of plates as the method of internal fixation, also placing on record the successful result of primary suturing of the radial nerve. A moderately extensive search of literature has failed to reveal a report of a case similarly treated by the use of skewers.

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KRUKENBERG TUMORS OF THE OVARY

SECONDARY tumors of the ovary are of considerable importance clinically, because they may be mistaken for a primary lesion. Of special interest is the group of secondary carcinomas known as Krukenberg tumors. They are usually easy to diagnose at operation because of their characteristic gross appearance, and in some instances their presence may even be suspected before operation.

CASE REPORT.—A married woman, thirty-six years of age, complained of uterine bleeding and abdominal pain, each of two weeks' duration. Six months before the onset of the present symptoms she had given birth to a normal full-term infant, the ninth child. Since that delivery she had lost twenty-five pounds in weight. She did not complain of any symptoms referable to the intestinal tract, and symptoms of gastric disturbance could not be elicited on direct questioning.

The thyroid gland was slightly enlarged, the heart and lungs were normal, the abdomen was full and rather tense. There was some tenderness in the region below the umbilicus. On percussion the abdomen was tympanitic in the mid-line, but dull in the flanks. The dulness was shifting. No tumor masses or abdominal viscera could be palpated. Vaginal examination revelead that the cervix was lacerated. The uterus was not enlarged. A bulging mass was found in the posterior cul-de-sac. The outlines of this mass were indefinite. Hæmoglobin 79.2 per cent. Sedimentation time rapid, 58 per cent. at the end of two hours.

When at operation the abdominal cavity was opened it was found to be filled with clear, straw-colored fluid, but the last portion to be removed was turbid. The blood vessels of the small intestines were injected. A tumor in the right ovary and a smaller, similar one in the left ovary were found. These were floating in the peritoneal cavity, fixed only by their pedicles. The fallopian tubes were œdematous and injected. A hard, indurated area could be palpated in the stomach. The ovarian tumors were removed.

The patient made an uneventful operative recovery, but died four months later of cachexia. A post-mortem examination was not done.

Pathological description of tumors removed: Gross.—Two tumors, the larger measuring 10 by 6 by 4 centimetres and the smaller 6 by 4 by 2½ centimetres, retain the general shape and outline of an ovary. They are similar in color and consistency. The outer surfaces are smooth, slightly nodular, and pale gray in color. The cut surfaces are of a diffuse, mucinous, gray structure. At the periphery the tissue is firm and homogeneous, but in the centre it is softened and broken down, with the formation of a few small cysts.

Fig. 1.—Signet ring and spindle cells. Low power.

Microscopic examination.—The tumor tissue possesses two main characteristics, and these are revealed in all sections from both tumors. It is composed largely of densely cellular areas alternating with some sparsely cellular ones, the latter having a large amount of mucoid ground substance. (Fig. 1.) The densely cellular areas are composed of large oval and round-cells filled with mucus. The nuclei are compressed to the periphery into a crescent shape giving the cells a signet-ring appearance. (Fig. 2.) The cells are massed together with very little stroma between them. The sparsely cellular areas are composed of spindle-shaped cells. These are loosely scattered about and separated by the mucoid substance, and are generally more numerous around the blood vessels. (Fig. 3.) These spindle-cells give this portion of the tumor a sarcomatous appearance. Occasional multinucleated cells are found. In some areas columnar cells without mucus are found, and these seem to have been polarized along a scanty stroma into tubule-like formations.

Fig. 2.—Signet ring cells. High power.

Diagnosis.—Bilateral Krukenberg tumors of the ovaries.

Discussion.—The diagnosis of Krukenberg tumors of the ovary is usually quite easy. They are nearly always bilateral and unequal in size. They characteristically maintain the shape of an ovary. Their opaque gray and lustreless color, and on section the mucoid degeneration, are usually suffi-

cient evidence to make the diagnosis. In addition, they are nearly always free of adhesions and seem to float freely in the peritoneal cavity from their pedicle. However, the tumors may be firmly bound to the uterus. Microscopically, the signet-ring cell formations, the fibroblastic or spindle-cell stroma, and the mucoid ground substance are pathognomonic.

Krukenberg [1] (quoted by Jarcho) first described these tumors in 1896 and considered them of connective tissue origin and primary in the ovaries. He called them fibrosarcoma ovarii mucocellulare, and recognized their tendency to metastasize through the lymphatics. Numerous authors since Krukenberg have reported similar tumors and established that they are carcinomas and secondary to gastro-intestinal carcinoma. In the majority of the cases on record the primary tumor was in the stomach. Major,[2] in 1918, reviewed the subject and collected fifty-five authentic cases. Fallas,[3] in 1929, added twenty-three. Jarcho [1] states that Schlagenhaufer had collected seventy-nine

in 1902, but that he recorded sixteen of these as primary in the ovaries. In addition to the cases collected by Major and Fallas we have been able to find six additional cases in the literature.[4, 5, 6, 7, 8, 9] Of these, the case reported by Bourg and Cordier [5] was unilateral. Although there are cases on record in which the primary tumor had not been discovered, the evidence is overwhelmingly in favor of these tumors being secondary, and in the majority of cases they have been secondary to carcinoma of the stomach. Some authors (Marchand, quoted by Jarcho [1]) claim that these tumors may

Fig 3.—Spindle cells and mucoid ground substance.

be primary. However, unless the most accurate and complete post-mortem studies have been made, such cases cannot be accepted as proved. The primary tumor in the stomach may be so small as to require serial sections (Major).[2]
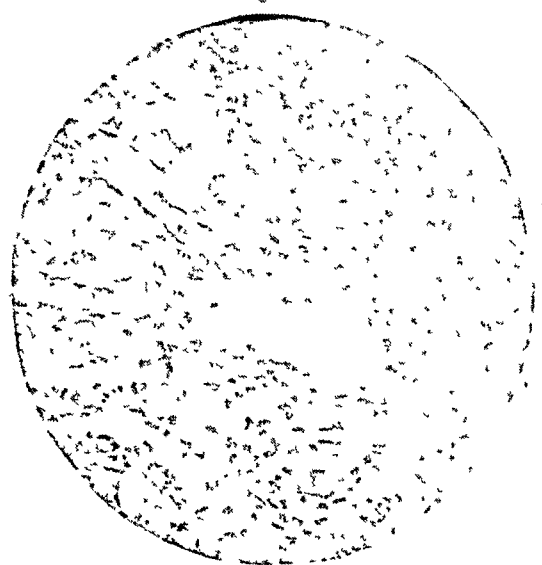
The theories presented to account for this rather unusual form of metastases are three: The first is the implantation theory, which implies that the cells have floated down through the peritoneal cavity from the primary tumor and have implanted themselves in the ovary. This theory is difficult to understand, because it would seem rather unusual that the cells in their course through the peritoneal cavity would not implant themselves on other organs. In addition, one would expect to find on histological examination evidence of implantation on the outer surface of the ovaries. Numerous sections taken through our specimens failed to reveal tumor cells on the outer surface. Jarcho [1] records a similar experience. The second theory is that the tumor cells reach the ovary by the blood-stream. The symmetrical

distribution of the tumor cells in the ovaries might be explained on this basis. The third theory is that the tumors arise as a result of retrograde lymphatic involvement, and this would imply that the lymphatic cistern under the diaphragm has been blocked by earlier tumor involvement. The early development of ascites is somewhat in favor of this. The fact that later lymphatic extension occurs is additional evidence.

Conclusion.—An instance is reported here of Krukenberg tumors of the ovaries. Six additional reports have been found in recent literature, bringing the total number on record to eighty-five. Until a primary tumor elsewhere has been ruled out, this condition must be considered as metastatic. The gross appearance and microscopic structure of these tumors are characteristic.

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RECONSTRUCTION OF ANAL SPHINCTER BY MUSCLE SLIPS FROM THE GLUTEI

In the Annals of Surgery for August, *1929*, Dr. J. Louis Ransohoff, of Cincinnati, Ohio, reports a case of successful reconstruction of the anal sphincter by the use of Wreden's method of reconstructing voluntary anal control. He also refers to two cases reported by H. B. Stone, of Baltimore, one of which was successful. Wreden's method is by the use of strips of fascia and is used in cases where the sphincter is still present. I wish to report a case with loss of the entire sphincter muscle in which anal control was obtained by the use of muscle slips from the glutei. In looking up the literature on this subject I found that this procedure was first reported by Schoemacher [1] in 1909. His procedure is practically the same as that which I used. In both our cases the sphincter was gone.

Case.—W. C., male, forty-six years, was first seen July 17, 1929, complaining of protrusion of the rectum of six months' duration and recently bleeding. He had been operated upon five years previously for carcinoma of the rectum at which time an excision of the tumor was done by the Kraske technic, removing the coccyx, lower bowel

[1] Plastische Ersatz des Sphincter Ani. Verhandl. d. deutsch, ges. f. Chir., vol. x, pp. 177–179, Berlin, 1909.

and sphincter. The end of the healthy bowel was drawn through the operative opening near the sacrum. The patients recovery was uneventful and up to the present complaint, bowel control had been maintained by stool consistency as in colostomy. About one year ago owing to family and financial worries, the patient became careless of his physical condition. He also began drinking heavily. About six months ago, he noticed a protrusion of the bowel when straining. This gradually became more marked and for the last two weeks there had been bleeding which was quite pronounced. He could reduce this protruding mass but it would immediately prolapse upon assuming an upright position.

He was a fairly well-developed and nourished white man apparently in no pain. Head, eyes, ears, throat, teeth negative; heart and lungs negative, abdomen negative. The perineum showed a cauliflower-like red, angry-looking mass about the size of a grapefruit with several ulcerated bleeding areas covered with a dirty slough. On reduction of this mass the perineum showed a jagged scar in the centre of which was an opening about two inches in diameter, the circumference consisting of a thin ring of scar tissue. No muscle was present. The protruding bowel measured about four inches in diameter. No signs of malignancy were noted. In view of the fact that the sphincter and the levatores ani had been removed at the previous operation, it was thought that the removal of a circular cuff from the prolapsed bowel plus the manufacturing of an artificial sphincter from gluteal slips might prove successful.

Operation.—Under gas-oxygen-ether, a circular incision was made about one inch away from the rectal opening, leaving one inch uncut anteriorly. The bowel was freed from the surrounding tissues beyond the upper limit of the protruding mass. It was found to be especially adherent to the sacrum posteriorly, requiring considerable effort to dissect loose. A circular cuff about one and one-half inches in width was taken from the bowel down to the muscular layer. The mucous membrane was then joined with an intestinal stitch, and the mass replaced in the pelvis. As the coccyx had been removed previously, the operative area was bounded posteriorly by the sacrum and postero-laterally by the glutei. A strip of muscle about one-half inch wide and long enough to reach below the anterior of the bowel orifice was cut from each gluteus, leaving its origin intact. These strips were then fastened together anterior to the bowel, drawing them through a tunnel which had been made through the scar tissue which was left at this point. This secured the bowel opening in a hammock of muscle. Owing to the wide separation of the muscles at the sacrum, it was found impossible to fasten them together posteriorly merely by sutures. Therefore the medial portions of the muscle bands were incised and swung behind the anal openings and fastened. Laterally, these were also fastened to the main muscles. Number 1 40-day chromic catgut was used for the muscle suture. The rectum was thus completely surrounded by a band of muscle. The skin was then closed with interrupted non-absorbable sutures, drains being placed in each ischio-rectal fossa. The patient's convalescence was stormy owing to the fact that on the seventh day he obtained some whiskey, became intoxicated, sitting down and tearing out the stitches. The wound became infected requiring daknization but the muscle platform held, and gradually the incision healed. Two months later, the wound was entirely closed. At that time the bowel opening permitted the introduction of two fingers and the patient, by contracting the glutei, pulled the bowel posteriorly, compressing the fingers quite forcibly. Two months later the patient stated that he had nearly perfect bowel control. He had not soiled himself for the last month. He however still dieted very carefully and he was told that, undoubtedly, he would have to continue to do so to a certain extent for the rest of his life. He has not been seen since then, a period of nearly five months. When last heard from about a month ago, he wrote that he was feeling fine, had gained weight and that his bowel control was perfect.

This technic which was elaborated without the knowledge of Schoemacher's previous work differs from his only in the exact procedure, the

idea and the anatomical structures used being the same. This technic, unlike Wreden's, is applicable to cases in which there is no sphincter and judging by our case the chances of success are good.

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RUPTURE OF A PRIMARY BRONCHUS FROM COMPRESSION OF THE THORAX WITHOUT BONE INJURY

The rupture of a bronchus as a result of compression of the thorax is unusual. Where there is no injury to the overlying bony thorax, it is a rarity, and such cases seem worthy of report. In 1912, Schönberg[1] reported three cases of his own. In two there was no bone injury, and in one there was a fractured rib, but no injury to the pleura. He also collected from the literature thirteen cases of bronchial rupture in which thoracic compression was the dominant feature. In only four of these, however, was there definite evidence that no overlying ribs had been fractured. Since then, King,[2] Mumford,[3] and Thomas[4] have each reported single cases in which bronchial rupture followed compression of the thorax and in which there was no fracture of the overlying bony frame work. To these cases we can now add the following report:

A robust young negro, of nineteen, fell from the front fender of a truck and was crushed between this vehicle and the road bank. Pressure was relieved only after his body had made nearly a complete turn, the maximum force being exerted on the antero-lateral portion of his right chest. Following this he became cyanotic, had great difficulty in breathing, and presented the picture of shock. Breathing was possible at this time only when the patient was recumbent. He was taken at once to the University Hospital.

On admission there was cyanosis of the face and neck, subcutaneous emphysema of the right upper chest and supraclavicular region, and marked dyspnœa. There was no evidence of injury to the chest wall. The only other abnormal sign recorded was a diminution in the breath sounds over the right chest. Temperature 101.2°, pulse 108, respiration 22. An X-ray of the chest was taken and the following report made: "A flat film of the chest shows a partial collapse of the left lung with displacement of the left diaphragm The right lung shows a somewhat homogeneous increase in density, probably caused by pressure plus congestion. Over the right chest there is extensive subcutaneous emphysema which runs well down into the axilla and as high as the soft tissues of the neck. No evidence of bone injury can be demonstrated in the thorax. Conclusions: Left pneumothorax with cardiac and mediastinal displacement to the opposite side. Extensive subcutaneous emphysema over the right chest. Atelectasis of the left lung with beginning congestion of right lung." (See Fig. 1.)

When first seen by one of us, several hours later, the only new findings noted were an increase in the respiratory rate to 50 and acceleration of the pulse rate to 130. There was evidence of a partial left pneumothorax. It was thought that the patient was suffering from mediastinal emphysema and a pneumothorax due to a rupture of the lung. Two hours later, there having been no change in signs, it was decided to aspirate the left pleural cavity to ascertain the presence of a valvular pneumothorax, planning to establish drainage should such be found. Accordingly, with the patient in a sitting position, a needle was inserted through the seventh interspace in the left mid-axillary

line. The rubber tube attached to the needle had its free end placed under normal saline solution and air bubbled out at a rapid rate. After a few minutes air ceased to flow and there was evidence that a slight negative pressure existed. The needle was kept in place for about twenty minutes in order that we might be certain that there was no continuous leakage of air into the pleural cavity. During this procedure the patient's condition twice became critical but on each occasion there was response to stimulation with caffein and adrenalin.

Following the aspiration the patient continued to go steadily down hill and died sixteen hours after the accident. There was no increase in the extent, or tension, of the subcutaneous emphysema and it was felt that no operative interference was indicated.

Abstract of necropsy findings.—"Over the right cheek bone there was a large superficial abrasion of the skin. Over the upper right thoracic region there was sub-

Fig. 1 —Rontgenogram of chest showing partial pneumothorax on left and subcutaneous emphysema on right.
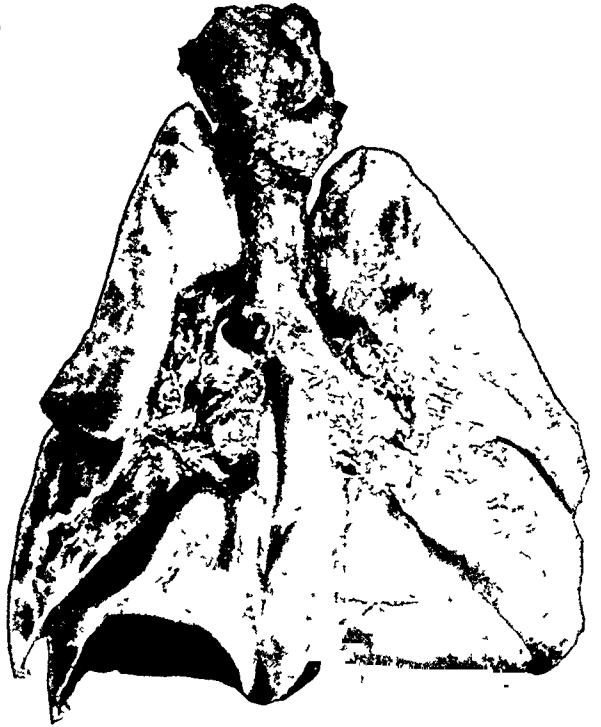
Fig. 2 —Photograph showing transverse rupture of right main bronchus

cutaneous emphysema, giving a crackling sensation on palpation. The subcutaneous tissues, particularly under the pectoralis major muscle, were markedly emphysematous and showed definite areas of hæmorrhage. The pleural cavities on either side showed no signs of inflammation or of fluid. The mediastinal structures and heart were in normal position. There were no puncture wounds of the parietal pleura and no fractures of the ribs or sternum could be seen. The tissues of the mediastinum were emphysematous and contained irregular splotches of hæmorrhage into the tissues. There was no purulent exudate.

"A complete transverse rupture of the right main stem bronchus was found five centimetres below the bifurcation of the trachea. (Fig. 2.) The rings of the bronchus with their mucosa were completely separated. The peribronchial tissues were not involved, except on the anterior aspect. The tissues were somewhat congested but no purulent material was present. The bronchial lining was also markedly congested and inflamed, but no exudate was present. No gross pathology of the cartilaginous rings was noted.

"The lungs were both of normal size and showed only an extreme congestion toward the bases. A close inspection of the left lung did not reveal the cause of the pneumo-

thorax found ante-mortem. Each lung contained an old healed tuberculous process in its apex. The heart, kidney, spleen, and liver were all apparently normal except for a bluish-purple discoloration, apparently an internal cyanosis of all the organs."

There seem to be two possible explanations for the presence of air in the left pleural cavity before death. The first is, that there had been a very small rupture of the lung which allowed the escape of air into the pleural cavity but which became sealed when the pressure of the air became sufficiently great. This would be compatible with the findings at the time of the aspiration of the chest but not with the evidence of an intact lung as found at autopsy. However, it must be possible for a small rupture to appear completely sealed after sixteen hours. The other possibility is the escape of air through a temporary opening in the mediastinal pleura. This is certainly less tenable as the ruptured bronchus from which the air would come was on the right and there was no leakage of air from it into the right pleural cavity. The origin of the interstitial emphysema is more obvious. The air escaped from the mediastinum along the deep fascial planes into the neck and thence over the upper chest and into the right axilla. This course has been observed both clinically and experimentally.[5]

The mechanism of bronchial rupture, as suggested by Schönberg, would seem to cover adequately the findings in the case here reported. He believed that there are two important factors. The first is, the compression of the bronchus between the elastic chest wall and the rigid spine; and the other, the marked increase in pressure in the air passages due to the fact that at the time of impact the lungs are in an inspiratory phase and the glottis closed. The bronchi, being less resilient than the lungs and pursuing a horizontal course, suffer the more.

Diagnosis of the condition is rarely, if ever, made. The signs according to the location of the rupture and the involvement of the pleura will vary. As the force necessary to produce this injury must be great, there will also be damage to other mediastinal structures and to the lungs, which in turn will give rise to respiratory and circulatory symptoms. There will then be in all cases evidences of respiratory difficulty with probably a pneumothorax or subcutaneous emphysema, or both. If the period of acute symptoms is survived, the diagnosis and exact location of the rupture can be established by bronchoscopic examination.

There has been found the report of only one patient who survived a ruptured bronchus. This case was reported in 1928 by Krinitzki.[6] The diagnosis was not made, however, until an autopsy was performed twenty-one years later. The patient as a girl of ten had a full wine cask fall from a wagon on her chest. She had four ribs on her right side broken and she recovered slowly. Later, she had recurring attacks of right-sided pleurisy. Seven years after this she developed evidence of tuberculosis of the left lung, from which she died after fourteen years. At the autopsy, the left lung, although found to be extensively involved with tuberculosis, more than filled the hemithorax. The right lung was contracted and airless and was adherent to the pericardium. The right bronchus extended downward three centimetres from the bifurcation and ended in a blind stump surrounded by connective tissue. Three centimetres

farther along in the hilus was found the continuation of this bronchus with its proximal end embedded in scar tissue. A careful study of the over-lying ribs failed to reveal any evidence of an old fracture.

In considering the treatment of patients with bronchial rupture, certain fundamental points must be kept in mind. Primarily, any force sufficiently great to injure a bronchus must also greatly traumatize the mediastinal structures and throw the victim into a state of shock. This fact is of the greatest importance, for rupture of a bronchus *per se* may give no symptoms. Associated with the break in continuity of the air passage, there will be a tear of the pleura, rupture of the lung, or the establishment of an opening into the mediastinum. Œdema of the mediastinal tissues is almost inevitable and hæmorrhage not infrequent. The most important factor from the standpoint of treatment is the continuous escape of air from the ruptured bronchus. When this occurs its control is urgent and must be attended to even while the patient's shock is being combatted. With the continuous escape of air into the pleural cavity a tension pneumothorax will develop which will require valvular drainage. Air escaping into the mediastinal tissues will soon also reach the soft tissues of the neck. Incision in the episternal notch may be sufficient to give relief to this entrapped air, though it will at times be necessary to add suction, as suggested by Tiegel,[7] or, even, to perform mediastinotomy. In some cases, as in our own, there is no continuous leakage of air and accordingly no operative interference is indicated. Most of these patients, however, succumb to the trauma to the adjacent structures. If the patient survives the early critical period and evidence of an open bronchus persists, one might consider an attempt at operative repair of the bronchus. Closure of bronchial defects has been successfully done in experimental animals and the procedure has been suggested for human cases. However, treatment of the bronchial wound must be considered of secondary importance to the treatment of the acute phenomena.

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CONGENITAL CYST OF THE COMMON BILE-DUCT

AN INFANT, six weeks old, was admitted to the Jackson Memorial Hospital August 17, 1929. The child had apparently had a normal birth, but soon became jaundiced, the icterus steadily increasing. Two weeks after admission to the hospital, the child was circumcised, which operation caused an extreme bleeding, but this was finally stopped. At about the same time,

Fig 1 —Congenital cyst of the common bile duct
1 —Pylorus   2 —Papilla Vateri   3 —Cyst.   4.—Gall bladder   5 —Lig teres hepat

a progressive enlargement of the abdomen was noticed and the child refused nourishment. It had b e c o m e profoundly anæmic. Examination revealed a tumor in the abdomen. Ten cubic centimetres of the mother's blood were given intramuscularly. The child died on the night of admission.

At autopsy there was found a cyst about four and one-half inches in diameter, present below the liver, carrying on its anterior surface the extended duodenum. (Fig. 1.) Pushing the duodenum forward, this sac was found to be in communication with the common bile-duct on two sides. The cystic duct appeared normal, but the gall-bladder was collapsed. The pancreatic ducts opened into the same cyst. The tumor contained bile. There was some bile present in the duodenum. The direction of the common duct at reaching the papilla of Vater was from left to right and not as in the normal, from right to left.

The origin of this rare condition, a so-called idiopathic choledochus cyst, is explained by some authors with the supposition of an abnormal weakness of the wall of the common duct. Others believe it due to the presence of ectopic pancreatic elements. In nearly all cases (about twenty have come to observation) the above-mentioned abnormality of the course of the intra-duodenal part of the common bile-duct was present. Most authors believe that this fact leads to the occlusion of the duct by a valve mechanism as soon as the duodenum widens, which, in normal cases, would tend to open

the papilla. Due to the extreme rarity of this condition, the diagnosis has been made in only a few of the known cases. Two cases, however, have been operated on with success. The prognosis is rather unfavorable, since, in addition to the usual danger of cholemia, an infection of the stagnated contents of the cyst usually takes place.

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PAROVARIAN DERMOID CYST

AUGUST 11, 1929, a woman, thirty-seven years of age, was admitted to the hospital, suffering from pain and tenderness in the right lower abdominal quadrant, nausea and vomiting, all lasting during the previous twenty-four hours.

The patient's health had always been good. There was some slight discomfort in the right lower quadrant for the past ten years, but never embarrassing. There was no history of intestinal upset or pelvic inflammation, patient was six months pregnant.

Immediate operation was done as follows: Right rectus incision about three inches long. After packing away the intestines, a large bluish mass about as large as a medium-sized grapefruit came into view. The mass was clamped off at the pedicle and removed. The appendix was normal, also the left ovary.

The surgically removed specimen consists of three parts (Fig. 1): (1) The cyst itself, irregularly shaped, of about six inches diameter, discolored by congestion. (2) The Fallopian tube, somewhat thickened and blood-tinged. (3) The ovary, apparently normal, containing a corpus luteum. The cyst apparently developed within the broad

FIG. 1.—Parovarian dermoid cyst ovary.

ligament, distinctly apart from the ovary, and therefore must be considered as a parovarian cyst. On opening it, the characteristic conditions of a dermoid cyst were found (sebaceous débris and hairs; there were no teeth present).

There seems to be little to be found in literature about parovarian dermoid cysts. The few papers which were available for me, dealing with this subject, are the following: *Mattoli* described one case in 1895. He thought the condition to be of considerable rarity. *Tourneux* and *Fabri* in 1914 described a

case and thought the condition to be extremely rare. In the same year, however, *Vautrin*, in a paper dealing with dermoid cysts, expressed the opinion that most of the dermoid cysts believed to originate in the ovary are, in fact, of parovarian origin. Based on a series of observations, he stated that it is frequently of parovarian origin at the periphery of the ovarian hilum. On the posterior side of the wing of the Fallopian tube, the dermoid cysts are encountered. The location preferred by the dermoid is the periphery of the ovary, and it sometimes encroaches in such a way that it could be considered as included in the ovary. However, Vautrin states it remains distinct from the glandular parenchyma, from which it is easily separated without involving the ovigenous bed. Four times, the author has verified this fact, but that the relationship of simple proximity may easily be made evident, the cyst must still be of small size. From the time when it takes on an important development, its relation with the gland becomes more intimate, so that it finally cannot be distinguished from an intraovarian tumor.

Literature: Mattoli: Att. redic. d. A. de Perugia, vol. vii, p. 45, 1895. Tourneux and Fabri: Arch. Med. de Toulouse, vol. xxi, pp. 83-87, 1914. Vautrin: Bull. de la Soc't Obstet. et Gynec. (Paris), vol. xvii, pp. 588-599, 1914.

<div align="right">
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</div>

From the Laboratory of Pathology of the James M. Jackson Memorial Hospital.

OSTEOPERIOSTEAL BONE GRAFTS *

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In 1926, Dr. George Wagoner and I proved by a series of experiments that it was possible to produce fixation of a joint in dogs by an extra-articular osteoperiosteal bone graft.[1]

A patient with a recent fracture of the internal condyle of the femur was referred to me. (Fig. 1.) The patient was admitted to Saint Agnes Hospital on September 6, 1927, and operated upon on December 28, 1927. This patient had an old infected arthritis of the knee-joint and on account of the pain and disability, I decided to ankylose the joint. It would have been difficult in this particular case to have performed a whole thickness graft and an extra-articular osteoperiosteal bone graft seemed to be indicated. (Fig. 2.)

The extra-articular graft was performed by making an incision in the lower portion of the thigh above the capsule of the knee-joint and extending this through the skin, fascia and muscles to the femur. A second incision was made over the upper end of the tibia and extended through the skin and fascias to the bone. By undermining the skin between these two incisions a subcutaneous tunnel was made. The periosteum over the exposed surface of the femur and the tibia was elevated and the surface of the bone chiseled or rongeured off, exposing roughened bone. An osteoperiosteal graft was obtained from the tibia and wrapped in rubber dam. One end of the graft was introduced into the wound over the tibia, then through the tunnel to the wound on the lower end of the thigh. The rubber dam was removed and one end of the graft was secured to the femur and the other end to the tibia. The wounds were sutured and the leg was placed in a plaster case. (Figs. 3, 4, 5, 6, 7.)

The growth, as shown in the X-ray picture, illustrates what occurred better than any description could. The joint is now fixed and the patient walks without a cane or crutch.

The thickness and strength of a bone graft depends upon the amount of weight and strength that is placed upon it. I am sure there is a distinct indication in joint disease for an extra-articular osteoperiosteal bone graft. It is a simple matter to remove this bone graft at any time in the future if it becomes necessary. Some years ago, I had the opportunity of observing a rather large number of bone grafts performed for loss of structure of part

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*Read before the Philadelphia Academy of Surgery, March, 1930.

[1] Transactions of American Medical Association, Section in Surgery, 1926.

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FIG. 1.—X-ray of joint before bone graft.
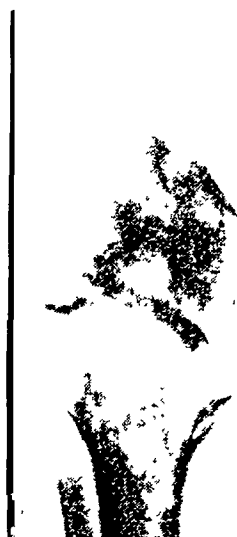
FIG. 3.—Time of operation.
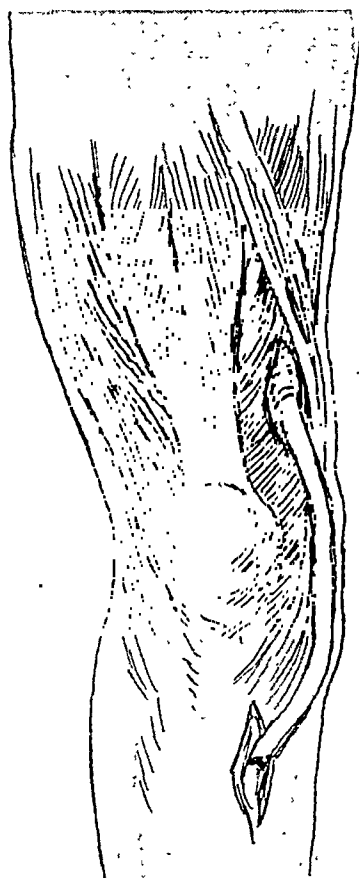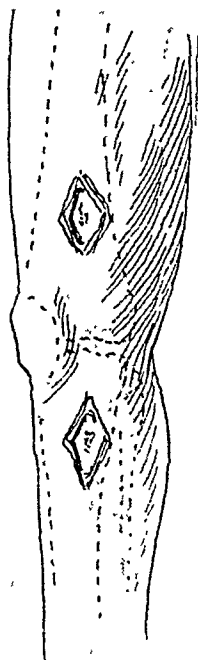
FIG. 4.—Three months after operation.

FIG. 2.—Extraarticular osteoperiosteal bone graft.

FIG. 5.—Six months after operation.

FIG. 6.—Nine months after operation.

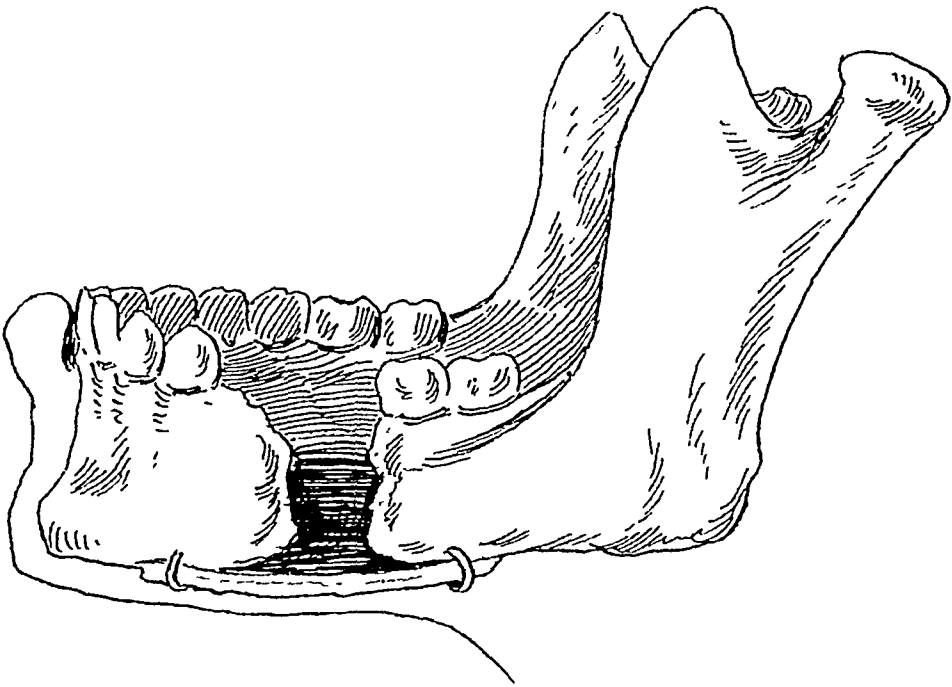FIG. 7.—One and one-half years after operation.

FIG 8.—Subcutaneous osteoperiosteal bone graft.

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of the lower jaw and for ununited fractures of this bone. Some of the surgeons used full thickness bone grafts from the tibia, rib, or crest of the ileum. Others used a pedicle flap with bone attached and still others used an osteoperiosteal graft. Some failures were noted in all types. The pedicle flap containing bone was the most satisfactory where it was possible to use it.

What were the reasons for these failures? First, the ends of the ununited parts of the bones were only too frequently thin and sclerosed. Second, in exposing the ends of the bone, one frequently penetrated into the oral cavity. Third, infection was the most frequent cause for failure. In osteoperiosteal grafts, perhaps this was due to the fact that the graft was laid in the wound without fixation.

Osteoperiosteal grafts always appealed to me on account of the ease and simplicity of application. In the jaw they are especially indicated as they readily conform to the curve of the bone. (Fig. 8.)

The subcutaneous method of performing a bone graft is the easiest and causes the least damage if a failure ensues. The portions of the bones where the grafts are attached are normal while the ends of the bones are hard and sclerosed.

In 1928, I thought if we bridged the gap from one side of the jaw of a dog to the other, it would be a good experimental test of the value of the subcutaneous osteoperiosteal bone graft. Accordingly the skin was incised over one side of the jaw and also on the opposite side. The bone was exposed, the periosteum elevated and the bone roughened. The skin covering the area between the two halves of the jaw was undermined and a subcutaneous tunnel was made to connect the two incisions. An osteoperiosteal bone graft was raised from the tibia and wrapped in rubber dam and then passed through the tunnel. The rubber dam was then removed and each end of the graft placed over the roughened bone and held in place by suturing the soft tissues. Note that the bones were not drilled.

In 1928, we performed three of these experiments but none showed complete union on both sides.

Dog No. 45.—Operated upon June 26, 1928. Killed 226 days later. Photograph shows the result of graft attached at one end only. (Fig. 9.)

Dog No. 38.—Operated upon June 27, 1928. Killed 225 days later. Result similar to dog No. 45. (Fig. 10.)

Dog No. 17.—Operated upon June 28, 1928. Killed 190 days later. At autopsy it was found that the entire graft had been absorbed.

Why did the grafts in dogs Nos. 45 and 38 fail to unite at one end?

First, we attempted to do what is recommended, that is, to lay the graft in place against the bone and hold it by suturing the soft tissues over it. We now think the graft should have been secured to the bone by wire or gut ligatures. The external surface of the bone should have been thoroughly removed, after elevating the periosteum. Second, the muscles between the halves of the jaw kept the grafts in almost constant motion.

FIG. 9.—Photograph of specimen of dog No. 45.

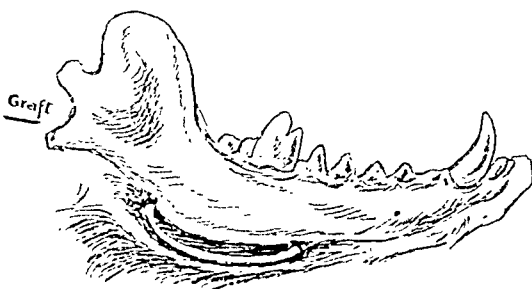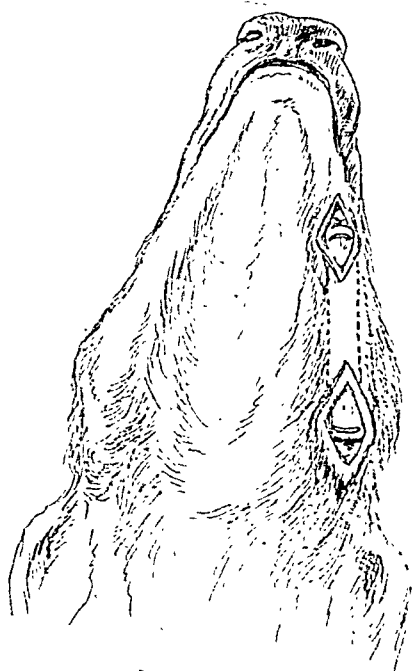FIG. 10.—Photograph of specimen of dog No. 38.

Graft

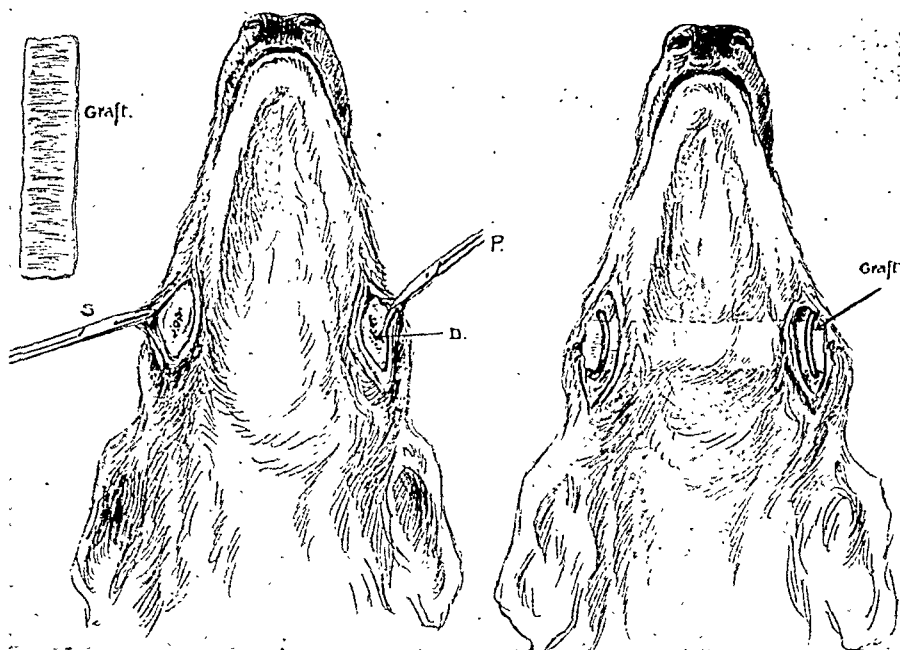FIG. 11.—Method of performing subcutaneous bone graft.

FIG. 12.—Method of performing subcutaneous osteoperiosteal bone graft.

FIG. 13.—Photograph of specimen of dog No. 56 from below upwards.

FIG. 14.—Photograph of specimen of dog No. 56 from above downwards.

In two other dogs, we made two incisions over the same side of the jaw—one incision at the angle and one in the canine tooth area. (Fig. 11.)

A subcutaneous tunnel was made connecting these two incisions. The periosteum was elevated and the bone roughened in each area. An osteoperiosteal graft was obtained from the tibia and wrapped in rubber dam. This was introduced into the tunnel and after removing the rubber dam, the ends of the graft were forced under the periosteum and the soft tissues sutured over them.

This was done in dogs Nos. 255 and 439. This is as nearly an ideal arrangement for a bone graft as is possible.

Dog No. 255.—One hundred days after the bone graft operation an autopsy showed that both ends of the graft had united to the jaw bone. The graft was excellent.

Dog No. 439.—The graft was in place for thirty days when, on account of distemper, the dog had to be gassed. The graft was growing but the anterior end seemed to be free.

FIG. 15.—Photograph of specimen of dog No. 49.   FIG. 16.—X-ray plate from dog No. 53.

In two dogs an osteoperiosteal bone graft was placed in the fascia or muscle but not in contact with bone. In both cases the grafts were absorbed. This confirms a fact long established by Ollier that a bone graft not in contact with bone is absorbed.

As the bone graft experiments performed in 1928 were not satisfactory, we decided to repeat the experiments in 1929, but instead of laying the grafts in place we carefully sutured them to the denuded bones with silver wire. (Fig. 12.)

Experiment No. 1: Dog No. 56.—An incision was made on each side of the jaw and a subcutaneous tunnel connecting the two incisions was made. The periosteum was elevated, the outer table of the bone removed and the bone drilled on each side. An osteoperiosteal graft was introduced and held in place by silver wires.

Note the perfect graft which is good and thick and strong.

The time which elapsed between the operation and the autopsy was 211 days (Figs. 13, 14.)

Dog No. 49.—Graft was in place for 213 days and remained attached to the left side only. Why did it remain attached to one side only?

From examinations during life and at time of autopsy, it is my opinion that the continuous action of the muscles caused the non-union of one end. (Fig. 15.)

Dog No. 58.—Graft was in place for 233 days. Before autopsy, the graft seemed to be attached on both sides. At autopsy, a little movement was present on the right side of the jaw. When the specimen was returned after maceration it was found that the graft had been attached at each end by fibrous tissue. (Fig. 16.)

Dog No. 43.—The same technic was followed. The graft was in place for 247 days. X-ray plates showed good growth and firm union on both sides. At autopsy, the specimen revealed a good, strong, well-united graft. (Fig. 17.)

FIG. 17.—Photograph of specimen from dog No. 43.

The results of the four bone grafts in 1929 were as follows: Two gave perfect results; one showed a good growth of bone but this was not firm at the ends; one showed a graft to be present but united at one end only; after seven months, we have three perfectly successful grafts and one with only one end complete.

Why are they not all perfect? I do not know. I can only attribute the non-union of the frequent movements due to pull of the muscles.

CONCLUSIONS

Full-thickness bone grafts are used and generally considered to be best, but osteoperiosteal bone grafts are indicated in selected cases.

My observations from both experimental and clinical studies are that the ideal conditions for successful osteoperiosteal bone grafts are:

1. The osteoperiosteal bone graft should contain a good supply of bone with the periosteum. The periosteum that is stripped from the bone will not develop bone.

2. One must be just as careful to fasten the graft to the bone as in full thickness graft.

3. The same care must be used in preparing the bed for the reception of the graft as in full thickness graft.

4. It requires a longer time for the graft to become solid.

5. In all bone-graft surgery, one should secure as complete immobilization as possible during the first two months.

6. The thickness and strength of the graft depend upon the amount of weight-bearing that is required.

BIOPSY BY NEEDLE PUNCTURE AND ASPIRATION

By Hayes E. Martin, M.D.

AND

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This paper is a presentation of technical procedures employed and results attained by securing tissue from suspected neoplasms for histological examination by needle puncture and aspiration.

The use of some form of trocar or needle to obtain tissue from the living subject is not a new procedure. The Mixter punch, a blunt-tipped trocar sharpened with the bevel on the inside, was devised by S. J. Mixter some twenty-five to thirty years ago and has been quite generally employed to obtain specimens of brain tissue. We have been unable to find any published record of its description. Ward,[1] in 1912, suggested needle puncture and aspiration of lymph nodes in the study of lymphoblastomas, and Guthrie,[2] in 1921, reported his observations on the aspiration of nodes in Hodgkin's disease. Goeller,[3] in 1920, devised a trocar with a spiral cutting tip for securing tissue from the prostate. Forkner,[4] in 1927, presented a method by which he obtains a small amount of tissue by the use of a dental broach inserted through an 18-gauge needle, and summarized the results of study of material so obtained by supravital staining.

The Mixter punch, Goeller needle, and the dental broach of Forkner are admirable devices for the purpose intended, but since biopsy by needle puncture is only occasionally indicated, these instruments will commonly be found unavailable. Although the Goeller needle has been employed at Memorial Hospital since its invention, we find, that unless it is made quite heavy, it is too delicate an instrument to keep in repair, and, in any case, it undoubtedly causes more trauma than the method which we present below.

Since 1926, we have employed aspiration with an ordinary 18-gauge needle attached to a Record syringe. This apparatus is always available in any clinic, hospital or office and therefore has the advantage of permitting impromptu and immediate use. We also believe that, with the proper technic and coöperation between the surgeon and pathologist, it is the puncture method most universally applicable. The observations here presented do not include the study of cancer cells from pleural or ascitic fluids, which has already been published [5] by one of us (E).

Indications and Advantages.—The indications for biopsy by needle puncture and aspiration are tumor masses which lie below the surface of normal tissue where surgical exposure is deemed contraindicated for any reason.

The common contraindications to biopsy by surgical exposure may be enumerated as follows: The danger of local or general dissemination of the disease or fungation of tumor tissue through the operative wound, the inter-

ference with subsequent therapeutic surgical procedures, the surgical risk (including hæmorrhage and infection) in obtaining specimens from certain deep-seated masses, and the lack of justification for any procedure involving physical or mental discomfort or expense to the patient, where the information to be gained may be of doubtful value to the patient or of academic interest only.

Biopsy by needle puncture and aspiration has, we believe, none of the above-mentioned disadvantages. The danger of local or general dissemination through the minute break in the tumor capsule produced by an 18-gauge needle is comparatively slight. The procedure has not in our experience
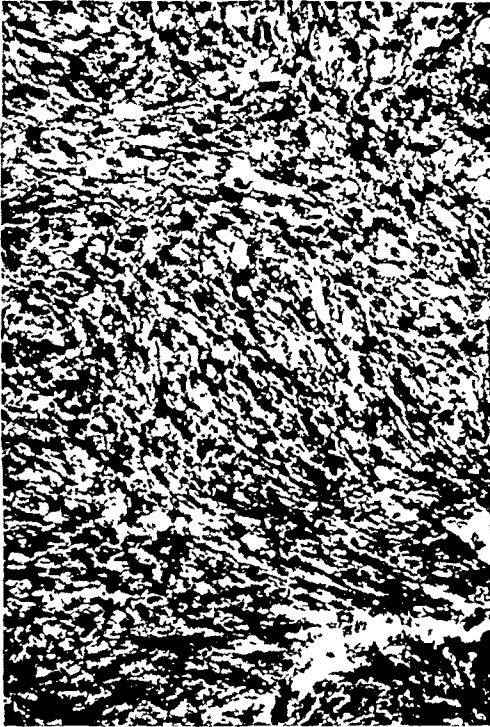
FIG. 1.—Spindle cell sarcoma of cheek. Paraffin section of aspirated material (Case 1).

FIG. 2.—Carcinoma of lung. Smear of aspirated material (Case 3).

caused sufficient trauma to modify the clinical setting for any subsequent treatment and the surgical risk is negligible, if sterile precautions are observed. We have not considered aspiration of abdominal tumors advisable, but we have several times successfully obtained diagnostic material from masses within the lung, without any untoward symptom either immediate or late.

In a clinic wholly devoted to the treatment of neoplastic diseases, we have several times obtained unsuspected pus or other fluid leading to the diagnosis of a benign lesion.

The procedure is accepted without question by the patient as it does not necessitate hospitalization, elaborate preparation, great discomfort, or more than a few minutes of time. It therefore makes possible histological diagnoses, otherwise either unobtainable or of necessity deferred.

Technic.—The special paraphernalia required is an ordinary 18-gauge needle five to ten centimetres in length (which should be new and sharp) and a twenty cubic centimetre Record syringe. For the preservation of the specimen, glass slides and a specimen bottle with 10 per cent. formalin are needed.

The skin at the site of the intended puncture is painted with iodine and a small area of skin infiltrated with 1 per cent. novocaine. With a bistoury pointed scalpel (No. 11 Bard Parker blade) a stab wound is made through the skin with the instrument held at right angles to the skin surface. This puncture of the skin facilitates insertion of the needle. An 18-gauge needle
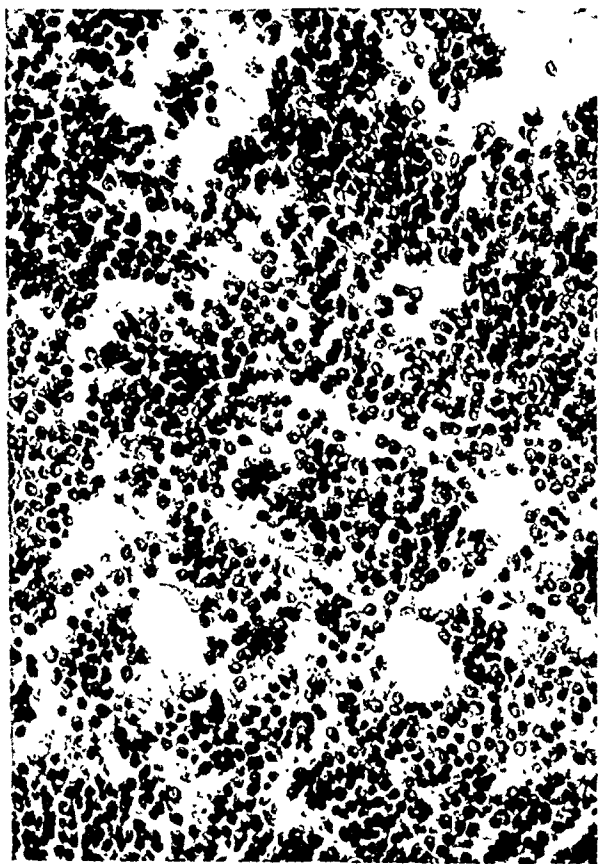
FIG. 3.—Endothelial myeloma of heel. Paraffin section of aspirated material (Case 4).

FIG. 4.—Carcinoma of lung. Smear of aspirated material (Case 8).

attached to a tightly fitting Record syringe is then inserted and advanced slowly through the superficial tissues until the point is felt to enter the suspected neoplastic mass. Guided by palpation with the disengaged hand, it is striking how readily a difference in consistence of the tissues can be felt as the needle enters a mass of neoplasm. When the point of the needle is felt to enter the tumor, the piston of the syringe is partly withdrawn so as to produce a vacuum and the needle slowly advanced one to three centimetres farther, depending on the anatomy and size of the tumor. Maintaining the vacuum, the needle is then withdrawn to the same distance and advanced again. This manipulation may be repeated two or three times at the discretion of the operator, *care being taken to maintain the vacuum when*

the needle is advanced or partly withdrawn. Aspiration with the needle at rest is not sufficient to draw tissue into the needle in most cases. By advancing the needle and aspirating simultaneously, a plug of tissue is both forced and drawn into the needle. Maintaining suction during partial withdrawal detaches the plug of tissue already within the needle. We have found this detail to be very essential. Before the needle is completely withdrawn from the tissue, the piston must be slowly released until the pressure in the needle is equalized, or better still, the syringe detached and the needle withdrawn separately, otherwise the aspirated material will be suddenly drawn and splashed over the interior of the syringe, making its collection difficult. While the needle is being advanced and withdrawn under negative pressure, a small quantity of blood mixed with fragments of tissue may enter the syringe, or a solid cylindrical mass of tissue may appear. In other cases, especially in the firmer masses, the syringe apparently remains empty, but after withdrawal, the needle is usually found to contain a plug of tissue.

After complete withdrawal of the apparatus, the syringe is detached from the needle, filled with air, attached and the contents of the needle slowly and carefully expelled on a glass slide. A small fragment of tissue should be left on the slide for smearing, and the remainder placed in the specimen bottle for fixation and staining by regular methods. If the needle is empty, small masses of tissue can almost always be found mixed with blood in the syringe, and these should, if necessary, be very carefully searched for. One or two of these small masses can readily be fished out upon a glass slide for smearing and immediate staining. In any case where the syringe contains blood or any tissue, formalin from the specimen bottle is poured into the open barrel of the syringe, agitated and returned to the specimen bottle.

Preparation of the Specimen.—In the average case, we have examined the material obtained by two methods: The shorter (a technic devised by one of us [E]) has the advantage of a reading in six to eight minutes and the longer, the advantage of a fixed and cleared preparation.

The Immediate Method.—The fresh tissue fragment on the glass slide is smeared by very firm flat pressure by another glass slide drawn once across. The smeared slide is fixed by heating gently over a gas flame until warm and dry, and is then prepared according to the following technic:

1. Alcohol (95 per cent.)—one minute.
2. Water—one minute.
3. Hæmatoxylin—one minute.
4. Water—one minute.
5. Eosin—one minute.
6. Alcohol (95 per cent.)—one-half minute.
7. Carbol-xylol—one-half minute.
8. Mount with Canada Balsam and cover glass.

Longer Method.—The remainder of the specimen is treated as any small biopsy, being carried through the stages of alcohol fixation and embedding in paraffin, great care being taken to collect and mass every minute particle

of tissue, since a positive diagnosis may often be obtained from the smallest fragment. Absolutely fresh 52°-56° C. paraffin should be used for embedding, and all particles massed together on the block and cooled immediately on ice. Every section cut from the block should be examined for fear that in dealing with such small particles, one might lose the opportunity of making a positive diagnosis. We usually cut six to eight sections and place them on a single slide. These are carefully examined and further sections cut if the first are negative and more material remains on the block.

In case a reading is desired earlier than by our routine laboratory technic, we use the following method of preparation which requires about three hours.

The quick paraffin method:

1. Formalin 10 per cent.—ten minutes.

2. Alcohol 95 per cent.—two changes, ten minutes each.

3. Xylol—two changes, one-half hour each.

4. Paraffin 54° C.—two changes, one-half hour each. (First three steps in incubator 37° C.)

5. Cut and stain.

Interpretation of the Histological Preparation.—The interpretation of the smear, if it is to be of value, requires first of all the experience of a pathologist fully familiar with the field of neoplastic diseases. He must be cognizant of the probable types of tumors peculiar to the region under consideration. He must be aware of the pitfalls introduced into his interpretation by the possible inclusion of crushed normal tissue into his aspiration. He must familiarize himself with the differences in size and relation between the shrunken, fixed tumor cell of the paraffin section and the crushed, loosened, rapidly-fixed tumor cells of aspirated material. He must be associated with a clinician whose clinical interpretation of the facts of the case is accurate and reliable, and he must be capable of intelligently utilizing what may be called his pathological imagination. By the exercise of great care in preparation of both the smear and residue specimen, accurate diagnoses may be made from aspirated material. (Fig. 1.)

The information gleaned from the direct smear is usually sufficient to distinguish between an inflammatory process with leucocytes and lymphocytes predominating, and a malignant tumor with its atypical cells occurring singly or in groups. The paraffin section of the material enables one to classify and often grade the malignant process. Material from lymph nodes, particularly those invaded by epidermoid or squamous carcinoma, often shows liquefied or necrotic material with shadows of epithelial cells, singly or in groups. Careful search of the slide, however, may reveal just one small group of viable cells upon which a definite diagnosis may be made. This type of material often suggests pus, but pus cells are seldom found in the smear, although it may contain many flocculi and shreds of epithelium.

Various types of cells are encountered in the smears: leucocytes. lymphocytes, plasma cells, or swollen endothelial cells which may readily be confused with tumor cells. We search particularly for groups of cells, atypi-

cal in size and shape with definite hyperchromatic nuclei, as it is upon these that the most positive diagnosis of malignant disease can be made. Too much reliance should not be placed upon the direct smear unless one finds a definite group of atypical cells. Any other information should be considered suggestive only, until the paraffin section is secured which can be done in three hours if necessary. In the paraffin section, overlapping of cells and false arrangements are obviated, permitting more accurate classification and grading.

We have been able, however, to make correct diagnoses, as between benign and malignant lesions, in practically all cases and to check the diagnoses in about 60 per cent. of cases by paraffin sections on biopsies obtained by usual methods at a later date during the course of the disease. The smeared preparation should first be examined in its wet state following hæmatoxylin which permits deeper staining if necessary. If the smeared material appears too thick, gentle pressure with another slide may alter the arrangement of packed cells, and afford a better opportunity for staining and clearing. Lymphoid tissue must be left a little longer in alcohol for fixation which enables the cells to take the stain more readily.

When endeavoring to interpret a given smear or section of aspirated material, one must consider the source from which the specimen was obtained. The type of histological structure through which the needle has passed in securing the specimen must be kept in mind. Any structure foreign to this locality encountered in the smear must be carefully noted. Thus if a specimen aspirated from a lymph node in which one would expect lymphocytes or possibly some swollen endothelial cells to predominate, contains instead many epithelial cells, single or grouped, atypical and hyperchromatic, one must admit the probable invasion of this node by an epithelial tumor. If there is central necrosis and liquefaction of a lymph node, the aspirated material contains many loose cells, some necrotic and poorly staining, yet the shadowy outlines of these foreign cells should lead one to search the field for clearer and more typical cells upon which to make a diagnosis. These foci are usually found.

Results of the Method.—During our earlier experience, we were able to secure tissue by aspiration in about 80 per cent. of the cases attempted, the failures usually being in the harder fibrous tumors. With more experience and by more careful attention to the technic of aspiration, we practically always secure tissue. Where tissue was obtained, we have been able to distinguish between its malignant and benign nature in all cases and as our pathological staff becomes more familiar with the examination of tissue smears and fixed aspirated material, we are more often able to definitely classify the tumor process.

In Table I are listed sixty-five cases of neoplastic disease in which the diagnosis has been made by this method. In about 60 per cent. of the cases in this series the aspiration diagnoses have been checked and confirmed by histological sections obtained and prepared in the usual manner. We have

BIOPSY BY NEEDLE PUNCTURE AND ASPIRATION

TABLE I

Case No.	Clinical diagnosis	Site of aspiration	Histological diagnosis of aspirated material
1.	Tumor of cheek	Primary tumor through cheek	Spindle-cell sarcoma*
2.	Mediastinal tumor perforating sternum	Through skin over sternum	Solid cellular malignant tumor without definite epithelial character resembling lymphosarcoma or thymic tumor
3.	Tumor of lung	Lung tumor through posterior chest wall	Epidermoid carcinoma
4.	Tumor of heel	Heel	Endothelial myeloma
5.	Tumor of cheek	Cheek	Small-celled alveolar carcinoma,* salivary gland type
6.	Carcinoma (?) antrum	Antrum through cheek	Glandular carcinoma,* adenoma malignum
7.	Carcinoma (?) antrum	Antrum through cheek	Malignant epithelial tumor, probably transitional cell carcinoma*
8.	Tumor of lung	Lung tumor through posterior chest wall	Epidermoid carcinoma
9.	Carcinoma of tongue	Questionable metastatic neck node	Squamous carcinoma*
10.	Carcinoma (?) of thyroid or larynx	Tumor at anterior base of neck	Epidermoid carcinoma, probably from larynx
11.	Carcinoma (?) of thyroid or larynx	Tumor at anterior base of neck	Epidermoid carcinoma
12.	Sarcoma (?) of mandible	Primary tumor through alveolus	Chondrosarcoma*
13.	Adenoid cystic epithelioma of scalp	Metastasis in ilium at sacro-iliac joint	Adenoid cystic epithelioma*
14.	Post-operative tumor of submaxillary gland	Recurrence in submaxillary region	Adenoma malignum*
15.	Tumor of breast	Breast tumor	Loose malignant epithelial tumor,* no definite structure apparent
16.	Tumor of breast	Breast tumor	Alveolar carcinoma*
17.	Tumor of breast	Breast tumor	Malignant epithelial tumor consistent with breast carcinoma*
18.	Tumor of breast	Breast tumor	Malignant epithelial tumor consistent with breast carcinoma*
19.	Carcinoma (?) of larynx	Neck node	Squamous carcinoma
20.	Tumor of breast	Breast tumor	Malignant epithelial tumor consistent with breast carcinoma *
21.	Carcinoma (?) of sigmoid	Subcutaneous metastasis of chest wall	Adenocarcinoma*

* Indicates that the aspiration diagnosis was confirmed by paraffin section on larger biopsy obtained by the usual methods.

TABLE I—*Continued*

Case No.	Clinical diagnosis	Site of aspiration	Histological diagnosis of aspirated material
22.	Tumor of neck	Neck mass	Hodgkin's disease
√23.	Cystic tumor of jaw	Jaw tumor	Malignant epithelial tumor*
24.	Carcinoma (?) of larynx	Neck node	Squamous carcinoma
25.	Tumor of neck	Neck mass	Squamous carcinoma
26.	Carcinoma of tongue	Questionable neck node	Squamous carcinoma*
27.	Carcinoma (?) of antrum	Antrum through cheek	Squamous carcinoma*
28.	Tumor of neck	Neck node	Epidermoid carcinoma*
29.	Tumor of soft palate	Soft palate	Mixed tumor, salivary gland type*
30.	Carcinoma of floor of mouth	Submental node	Epidermoid carcinoma*
31.	Carcinoma of tongue	Neck node	Epidermoid carcinoma*
32.	Cervical adenopathy	Neck node	Transitional-cell carcinoma
33.	Carcinoma of tongue	Neck node	Epidermoid carcinoma*
34.	Carcinoma (?) of tonsil	Neck node	Malignant tumor, either a lymphoepithelioma or lymphosarcoma
35.	Cervical adenopathy	Neck node	Malignant tumor
36.	Carcinoma of cheek	Neck node	Epidermoid carcinoma*
37.	Cervical adenopathy	Neck node	Anaplastic epidermoid carcinoma
√38.	Sarcoma (?) of humerus	Tumor of humerus	Osteogenic sarcoma*
39.	Carcinoma of thyroid	Neck node	Clusters of tumor cells
40.	Carcinoma of face	Mass over parotid gland	Squamous carcinoma*
41.	Carcinoma of œsophagus	Neck node	Degenerative squamous carcinoma*
42.	Carcinoma of parotid gland	Neck node	Squamous carcinoma*
43.	Carcinoma of tongue	Neck node	Epidermoid carcinoma*
√44.	Sarcoma (?) of scapula	Tumor of scapula	*Primary bone tumor with giant cells of type found in benign giant-cell tumor, though this is not sufficient to exclude malignant bone tumor*
45.	Carcinoma (?) of submaxillary salivary gland	Submaxillary tumor	Tumor cells present, probably epidermoid carcinoma. (Later pathology after removal, mixed tumor, salivary gland type)

* Indicates that the aspiration diagnosis was confirmed by paraffin section on larger biopsy obtained by the usual methods.

TABLE I—Continued

Case No.	Clinical diagnosis	Site of aspiration	Histological diagnosis of aspirated material
46.	Epulis (?)	Tumor of alveolus	Giant-cell epulis*
47.	Carcinoma of tongue	Neck node	Liquefied squamous carcinoma*
48.	Carcinoma (?) of thyroid	Neck mass	Numerous large spindle tumor cells, some with mitoses. Probably large spindle-cell thyroid carcinoma
49.	Transitional cell carcinoma of tonsil	Mass in scalp	Tumor cells present—type not determined.* (Specimen from tonsil—transitional-cell carcinoma)
50.	Lympho - epithelioma of tonsil	Diffuse swelling of forearm	Very cellular epithelial tumor, suggesting transitional-cell carcinoma*
51.	Lymphosarcoma (?) of neck	Neck node	Cellular epidermoid carcinoma
52.	Carcinoma (?) of antrum	Antrum through anterior wall	Schneiderian carcinoma*
53.	Cervical adenopathy	Neck mass	Squamous carcinoma
54.	Sarcoma (?) of humerus	Tumor of arm	Spindle-cell sarcoma, probably osteogenic
55.	Carcinoma (?) of prostate	Prostate through perineum	Carcinoma
56.	Carcinoma (?) of thyroid	Thyroid tumor	Malignant tumor, type undetermined
57.	Carcinoma of soft palate	Neck node	Transitional-cell carcinoma*
58.	Carcinoma of tongue	Neck node	Squamous carcinoma
59.	Carcinoma of floor of mouth	Neck node	Epidermoid carcinoma*
60.	Tumor of anterior chest wall	Chest wall tumor	Tumor cells in sheets are spindle and polyhedral, would consider carcinoma—possible thymic, thyroid or bronchogenetic
61.	Tumor of thigh or femur	Thigh	Multinucleated tumor giant cells. Sarcomatous tumor probably neurogenic or myogenic
62.	Tumor of pelvis	Pelvic tumor	Masses of atypical cartilage cells—either chondroma or chondrosarcoma
63.	Cervical adenopathy	Neck node	Solid sheets of large lymphoid cells, consistent with reticulum-cell lymphosarcoma
64.	Tumor of breast	Breast tumor	Large number of spindle and polyhedral cells with atypical mitoses—sarcoma
65.	Tumor of thigh	Thigh tumor	Spindle-cell sarcoma—neurogenic

kept no definite record of the instances in which normal tissue, pus, or other fluid has led to an eventual diagnosis of a benign lesion. Obviously the

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* Indicates that the aspiration diagnosis was confirmed by paraffin section on larger biopsy obtained by the usual methods.

aspiration of normal tissue may not be considered alone as conclusive evidence of a benign process.

The actual value of this method of biopsy in selected cases depends upon the fact that diagnoses can be made without loss of time and in instances where there are definite contraindications or obstacles to securing tissue by any other method. If in any case tissue can readily and safely be secured in larger amounts by any other procedure, there is no advantage in aspiration. An analysis of the cases in Table I will illustrate indications and advantages of the method in our series.

Nodes of the Neck.—In almost half of the cases in our series, the aspiration was done on neck nodes or masses. The indications and value of this
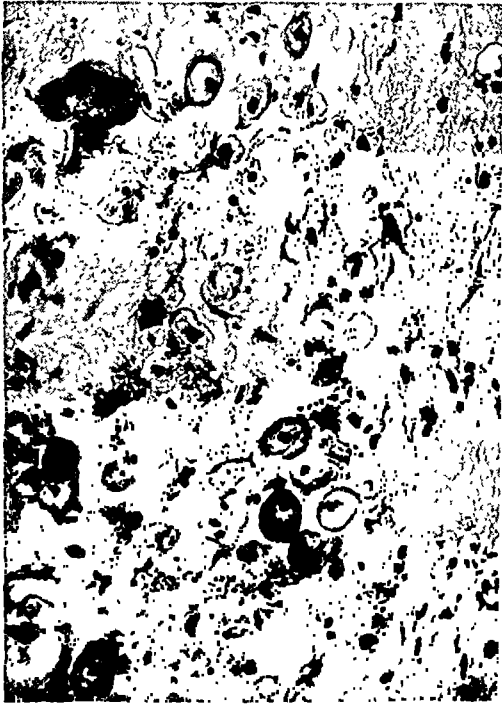

FIG. 5.—Chondrosarcoma of mandible. Smear of aspirated material (Case 12).

FIG. 6.—Adenoma malignum of metastatic neck node. Paraffin section of aspirated material (Case 14).

method of biopsy in neck nodes is illustrated by the citation of a few of these cases.

In Cases 22 and 25 there were firm solid masses in the neck without any other definite clinical or laboratory evidence of a primary or constitutional disease. Aspiration quickly established the diagnoses as Hodgkin's disease and squamous carcinoma respectively.

Cases 10 and 11 presented indurated fixed masses at the anterior base of the neck with moderate dyspnœa. Laryngeal examinations showed infiltration and pressure on the larynx, but no ulceration. The diagnosis lay between carcinoma of the thyroid and carcinoma of the larynx. Aspiration of the neck mass revealed squamous carcinoma in each case, establishing the larynx as the original site of the disease.

Cases 19 and 24 presented typical clinical pictures of moderately advanced carcinoma of the larynx. Biopsies taken, twice in each case, from ulcerating and granular tissue within the larynx, showed simply granulation tissue. Neck nodes in each case were aspirated and squamous carcinoma found, establishing the diagnosis for a prognosis and for completion of the records. In Case 2 a diagnosis of a malignant process was obtained for record.

In Cases 9 and 26 the diagnoses had been made by biopsies from the primary lesions, but in subsequently developing neck nodes, the question of their metastatic or benign nature arose in determining treatment. In each of these cases, aspiration definitely settled their metastatic character and
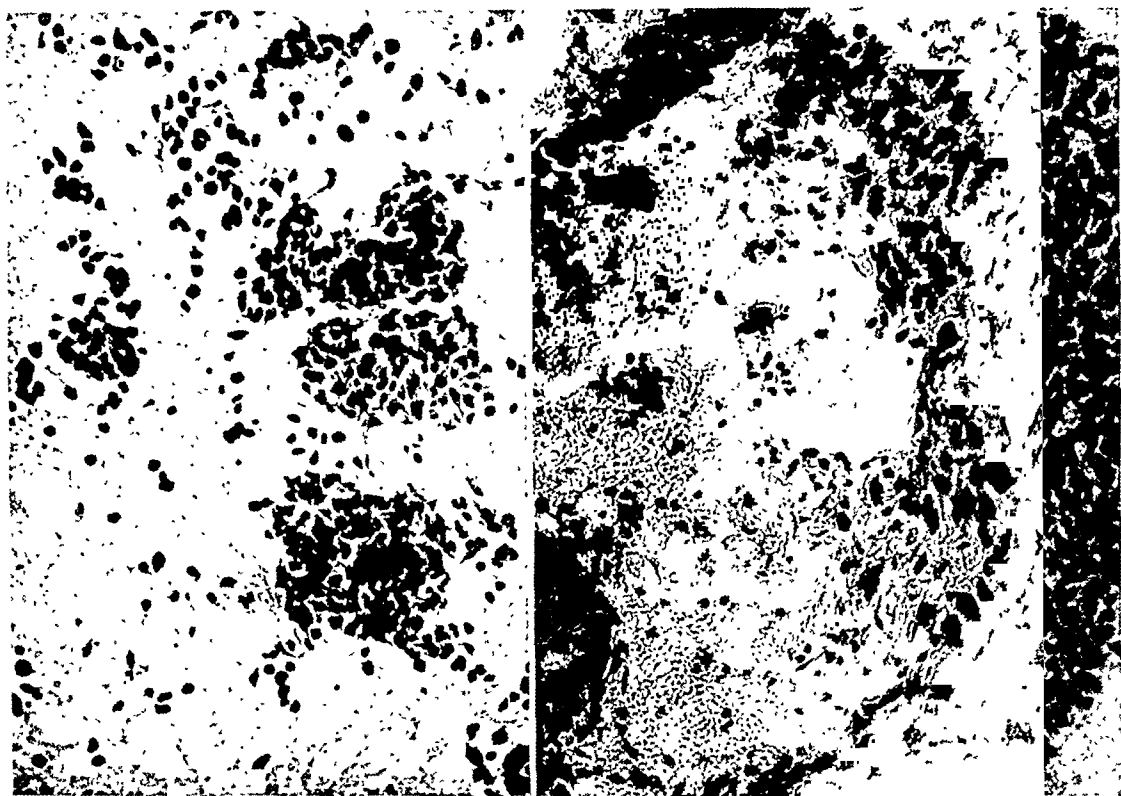
FIG. 7.—Carcinoma of breast. Smear of aspirated material (Case 15).

FIG. 8.—Epidermoid carcinoma of metastatic neck node. Smear of aspirated material (Case 24).

appropriate measures were taken. Case 14 came to Memorial Hospital with a local recurrence about eight months after operative removal of a submaxillary mass. We were unable to secure a pathological report from the operating surgeon, but aspiration showed adenoma malignum.

Intra-Oral Tumors.—In Cases 1, 23, 29, and 46 there were non-ulcerating tumors of the cheek and jaw in which incision carried with it the danger of fungation of the tumor. By aspiration we were able to diagnose them as spindle-cell sarcoma, parotid tumor, mixed tumor of salivary gland type, and epulis, respectively.

Tumors of the Antrum.—Unless the disease has perforated the hard palate or into the nasal cavity, biopsy must usually await antrotomy. In Cases 6, 7, 27, and 52 aspiration was done through the cheek and partly

eroded bone of the anterior antral wall. A diagnosis of carcinoma was made in each case without waiting for operation.

Tumors of the Lung.—In Cases 3 and 8, X-rays showed a mass within the parenchyma of the upper lobe of the lung. Bronchoscopic examinations were negative and offered no opportunity for biopsy. After a careful study of stereo-röntgenograms, a needle was inserted through the chest wall and material aspirated upon which a diagnosis of carcinoma was made.

Tumors of the Breast.—In Cases 15, 16, 17, 18, and 20 there was a real question in the mind of the surgeon as to whether he was dealing with benign or malignant tumors. This question might eventually have been decided during treatment at operation, but we believe that it has been of definite value, both to the patient and surgeon, to have an immediate definite diagnosis in order to plan and expedite both irradiation and possible surgery. In Case 64, there was a large non-ulcerating tumor of the breast in which aspiration made possible the rather rare diagnosis of sarcoma.

The danger of favoring metastases by the manipulation of aspiration in breast tumors is, of course, to be seriously considered but, where the diagnosis is much in doubt, it is ordinarily settled by surgical exposure and frozen section which would undoubtedly be a far greater factor in dissemination than simple puncture and aspiration.

Sarcoma of Bone.—In Cases 12, 38, 44, 54, and 62 diagnoses of various types of bone sarcoma were made from aspirated material. In two of these cases, the diagnoses were checked later by histological section of post-operative material and found correct. The danger of fungation of bone sarcoma through the operative incision is wholly eliminated by aspiration and it seems to us that the chances of general dissemination are slight. Coley [6] admits the hazards of surgical biopsy, but insists that it should be done in all cases of suspected giant-cell tumors of bone, in which conservative therapeutic measures (radiation or curettage) are to be used. He arrives at these conclusions after an analysis of thirty cases of supposed giant-cell tumors in which there was an error of 25 per cent. in röntgenray diagnoses in various clinics. His views are opposed by those who maintain that the dangers of surgical biopsy outweigh the advantages, should the case be one of malignant bone tumor rather than a benign giant-cell type. It seems to us that both sides of the question might be answered by an aspiration diagnosis.

Miscellaneous Tumors.—In Cases 2, 4, 5, 21, 28, 32, 34, and 45, the nature of various tumors, primary or metastatic, was determined without danger of fungation through an incision. In this group the wide range of usefulness of aspiration in the study of malignant disease is again illustrated. Quite often the knowledge of an individual case must remain incomplete because further investigation would cause unjustifiable suffering or other unfavorable consequences. In certain instances these investigations may not benefit the patient, but may be of great interest in the general study of the disease.

The importance of histological diagnosis in the treatment of neoplastic

disease needs no emphasis. In some clinics it is mandatory before treatment by radiation. Biopsy by surgical exposure is too often extremely ill-advised when casually performed by a surgeon who contemplates no further treatment, and it should be severely condemned when done in this manner without careful consideration and definite purpose.

· Biopsy by aspiration has, we feel, few, if any, disadvantages to the patient from the surgical standpoint. The interpretation of the histological picture (especially of the smears) requires both an experienced and sympathetic pathologist. Undoubtedly, larger specimens uniformly fixed and stained offer more satisfactory material upon which to render a definite opinion, but such a preparation can too often be obtained only at considerable disadvantage to the patient or too late to be of any particular value in outlining treatment. A post-mortem diagnosis never benefits the one most concerned, the donor of the specimen.

We do not advocate this method of biopsy in any case where larger specimens of tissue can be readily and safely secured by any other method. The chief disadvantage of biopsy by aspiration is that one diameter of the specimen is very small—the same as the bore of the needle. In such a small specimen the characteristic cell arrangement may be difficult to determine as, for instance, in glandular carcinoma. In a smeared specimen it is usually lost entirely. While the lack of definite cell arrangement in smears or very small fragments often prevents accurate classification of the lesion, one is still able to definitely determine whether such tissue is malignant or benign. The accurate classification of tissue specimens is quite often impossible with frozen sections and when one considers the difficulty experienced with frozen sections, often too thick or poorly stained, and compares the necessary time and equipment required for that method with the rapidity and ease of preparation of smears from aspirated material, it might well become the method of choice when fortified by paraffin section of a portion of the same material.

We are indebted to Doctor Ewing and Doctor Stewart for many helpful suggestions and for the interpretation of the histological findings.

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TRAUMATIC LESIONS OF THE BRACHIAL PLEXUS*

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In presenting these cases of traumatic lesions of the brachial plexus from the surgical clinics of J. Chalmers DaCosta, of the Jefferson Medical College, one is impressed with the improvement since the World War in the technic of the operative treatment of peripheral nerve lesions. The improvement in the treatment of these cases is not only because of the immense experience gained at the operating table during and subsequent to the War. but is augmented by a vast amount of scientific and experimental work. Sheehy and Tilney (1915) wrote on the development of the peripheral nerve. Heinemann (1916) disputed the accepted views of the internal topography of peripheral nerves. His publication (Arch. f. klin. Chir., vol. cviii, p. 107, 1916) definitely disproved the old and accepted view of the existence of definite nerve paths from the plexus to the periphery by showing that in the musculo-spiral, median and ulnar nerves there were many internal nerve plexi rather than one continuous pathway. The presence of these peripheral plexi no doubt explains the remarkably rapid improvement in Case II of this series. A man who had had a total motor and sensory paralysis of the brachial plexus of four months' duration regained muscle tone in the flexors of his forearm two weeks after operation. To use his own expression, "the softness of the flesh disappeared and it became firm." It would seem almost an impossibility for a continuous pathway to be reëstablished within this short period, a view held by Stoeffel (Zts. fur Orthop. Chir. Bd., vol. xxv, p. 505, 1910). But it would agree with Compton (Journ. Anat. and Physiol., vol. li, p. 103, 1916–1917) who verified the observations of Heinemann and added that one of the functions of the plexpleni in the nerve was to supply several routes to each muscle for the impulse to reach it. The function of the nerve plexpleni within the peripheral nerves would explain the early development of muscle tone in Case II, above cited, and would further lead us to believe that peripheral nerve plexi are more resistant to degeneration than is generally believed. This fact is verified by our observations in Case VI. The patient was not operated upon until four years after the injury. Subsequently, he had return of sensation down to the elbow and some return of power in some of the muscles of the shoulder girdle. A. P. Dustin (Ambulance de L'Oceon, p. 135, July, 1918) accepted Heinemann's and Compton's views on the internal topography of the peripheral nerves and wrote: "It is possible to establish as a Principle, that the identical arrangement is never found at the same level in two different individuals and that it is impossible to conceive of a fundamental systematization of a nerve

having funiculi as its anatomical basis." With these fundamental principles on the internal topography of peripheral nerves and the reëstablishment of impulses in divided peripheral nerves, surgery of the peripheral nerves was placed on a solid operative basis.

Let us now consider the etiology of brachial plexus—paralysis—overstretching and division of one or several of the component parts of the brachial plexus, due to a force which increases the acromiomastoid line, thereby forcing the head and shoulders apart. Were the overstretching and rupture of the nerve structure the only pathologic process present in these individuals, the conservative plan of treatment could be used more frequently and with more success, but, the presence of intraneural and extraneural hæmorrhage must be considered. Stookey, p. 25, Saunders and Co., 1926, shows a cross section of a peripheral nerve. A glance will show how well supplied the peripheral nerves are with blood, and no slight stretch of the imagination is required to envision the damage that can be done by free hæmorrhage within the sheath.

Case II is a striking example of the damage done by hæmorrhage within the nerves. There was complete paralysis of the brachial plexus below the roots, manifested by a total palsy of all the muscles of the shoulder and arm.

The early opening of the sheath before fibrosis takes place would anticipate much subsequent damage to the plexus.

If the conductivity of the nerve is interrupted by laceration, vulsion or gun-shot wound (the local pathology), what happens to the distal portion of the nerve? This was clearly explained by Waller in 1852, at which time he demonstrated that secondary degeneration took place when the periphery was severed from the ganglion cell. This is known as Wallerian degeneration. Stookey states: "Within twenty-four to forty-eight hours after an injury to a peripheral nerve the muscles supplied by the nerve will respond to mechanical and electrical stimulation. After four days, change in the myelin sheath is observed, and this is followed by segmentation of the myelin sheath and fragmentation of the neuraxis. At the end of the first week after the injury which causes degeneration, nearly all of the nerve fibres of the distal portion of the nerve present varying evidence of degeneration. The degenerative process is progressive up to the end of the third week, then degeneration reaches a resting stage in the form of syncytial, nucleated, protoplasmic bands, the product of hyperplasia, of neurilemma cells and the proliferation of their nuclei within the old neurilemma sheath." This constitutes a resting stage of degeneration in the peripheral segment and remains practically unaltered for weeks and months and may be indefinitely, as exemplified by one of our patients who was operated upon four years after he developed a complete paralysis of the brachial plexus. At the time of operation he had reactions of degeneration of all of the muscles supplied by the brachial plexus. This, of course, was to be expected as reactions of degeneration may be determined six

weeks after division of the nerves, if the studies are carried out by a competent man.

If the old theory of complete degeneration of the nerves were true and that restoration of function had to be reëstablished along a single neuraxis, it would seem impossible that any return of function could take place after a lapse of years, but with the understanding that the nerve reaches a resting stage of degeneration, one is justified in operating upon patients with divided nerves even a year after the injury.

Diagnosis.—Some times it is questionable whether the brachial plexus is injured above or below the clavicle. This is especially true in gun-shot wounds about the neck and chest and in cervical spinal column injuries. Three of our patients presented this problem. If one considers that the muscles of the shoulder girdle are supplied by the nerves coming directly from the roots or at their primary subdivision then paralysis of one or all of these muscles means a supraclavicular injury to the plexus; on the other hand, if all the muscles of the shoulder girdle are functioning normally the traumatism is below the clavicle.

While this method of diagnosis of the lesion is helpful, it is not sufficiently accurate to definitely localize the divided nerves. This information must be definite before the incision is made. A mental picture of the plexus, together with the site of the lesion, is most essential in making the correct diagnosis.

"The nerve root is a morphological unit; the nerve trunk a physiological unit." (Stookey.) Stimulation of a root produces contraction of both flexor and extensor muscles; therefore, division of a root produces paralysis of flexors and extensors. Stimulation of a nerve trunk produces flexion or extension and never both; likewise, division of a nerve trunk never produces paralysis of flexors and extensors. It follows that if there be both flexor and extensor paralysis, and the shoulder girdle muscles are functioning normally, the lesion is in the secondary cords. There is some variation in the formation of the brachial plexus in different individuals, especially between the fourth and fifth cervical roots and the first dorsal root. This variation is determined only by exposure of the plexus.

The brachial plexus is divided into nerve roots, two primary cords, three secondary cords, and their trunks and branches. The ventral and dorsal roots of a spinal nerve unite within the intervertebral foramen. Consequently, an evulsion involving the roots of the brachial plexus is often associated with a tear of the dura and the escape of cerebrospinal fluid. This pathology was found in Case I of this series. It is seldom that all the roots are divided. There is usually a combination of root and primary cord lesion.

Let us see what nerves have their origin in the roots of the brachial plexus—the dorsalis scapulæ, which supplies rhomboideii and levator anguli scapulæ; the long thoracic nerve which supplies the serratus magnus; the

phrenic nerve which is derived from the fourth and fifth root in the prefix type of plexus and from the fifth root alone in the postfixed type of plexus. Paralysis of any or all of the muscles supplied by these nerves means root pathology. The oculopupillary fibre of the cervical sympathetic is also a key to involvement of the cervical roots. These fibres supply the dilator pupillæ, the non-striated part of the levator palpebræ superioris and the orbital muscles of Muller, a small bundle of non-striated muscle which lies behind the globe of the eye. The pupillary dilator fibres arise from the cortical centre in the frontal lobe, pass along the brain stem to the pupil dilating centre in the medulla. They then descend in the lateral column of the spinal cord to the ciliospinal centres in the lower cervical region, emerging from the cord as pre-ganglionic fibres through the anterior roots of the first and second thoracic segment, and enter the inferior cervical ganglion of the cervical sympathetic by the white rami communicans. They then ascend as post-ganglionic fibres behind the carotid sheath in the neck to the gasserian ganglion and pass along the ophthalmic division of the fifth nerve as the long ciliary nerve to the pupil. When this pathway is destroyed as the result of an injury in the neck, there is ptosis of the eyelid, contraction of the pupil on the side of the paralysis, due to paralysis of the dilator pupillæ, and the eye is slightly sunken—"enophthalmos." Two patients of this series presented this picture.

While it is true there is no definite communication between the brachial plexus and the ciliary spinal reflex, the abolishment of the ciliary spinal reflex should lead us to make a careful investigation, to determine the presence or abscence of an injury to the upper roots of the brachial plexus.

The spinal roots divide to form the inner, outer and posterior cords of the brachial plexus. At the junction of the division of the fifth root, the suprascapular nerve takes its origin and consequently a paralysis of the suprascapular nerve would definitely isolate the site of the pathology. The suprascapular nerve supplies the supra- and infra-spinati muscles. We, therefore, conclude that in injuries to the brachial plexus, above the clavicle, there must be paralysis of some or all of the muscles of the shoulder girdle, the rhomboideii or levator anguli scapulæ, serratus magnus, supra-spinatus and infra-spinatus and sub-clavius muscles; whereas, in an injury below the clavicle, all the muscles of the scapula function normally.

There are three classical types of brachial paralysis: the upper cervical or Duchenne-Erb, the middle and the lower cervical. In three cases of our series, in which extensive paralysis was present, it was observed at operation that the primary rupture was not the sole cause of the paralysis; fibrosis and hæmorrhage were responsible for much of the damage—an observation which militates against the conservative plan of treatment.

Treatment.—The treatment of brachial plexus palsy, whether due to birth injury or to traumatism, is conservative and operative. For the conservative plan we can say little to encourage the use of this plan in traumatic cases.

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It does not correct the primary division of the nerve structures, and it does not prevent the secondary inflammatory fibrosis from taking place. Why hesitate when the simple operation of neurotomy will restore the function of many muscles by preventing inflammatory fibrosis and proper suturing, if done promptly, will restore a useful if not a perfect arm.

The technic of the operative plan of treatment may be found in detail in Stookey's book.

CONCLUSIONS

1. The distal portion of a traumatized or divided peripheral nerve is very resistant to degeneration.

2. Return of function may be obtained months and years after the operation.

3. Definite localization of the site of traumatism must be known. Direct force will often injure the lamina or the body of the cervical vertebræ, causing damage to the spinal cord, but does not traumatize the roots, trunks or branches, causing paralysis of the arms, which simulates avulsion of the plexus. These cases improve under the conservative plan of treatment.

4. Where the injury causes wide separation of the acromiomastoid line, we are dealing with local pathology in the plexus which requires surgical intervention.

5. Early surgical intervention prevents fibrosis and years of convalescence.

CASE REPORTS

CASE I.—*Traumatic Avulsion of Brachial Plexus.*—G. L., colored male, aged twenty-three years, M–6345, admitted to Jefferson Hospital December 19, 1924, with complete loss of power and sensation in left arm; pain and stiffness in neck.

Present Illness.—One week before admission to the hospital the patient was struck by some scaffolding which had fallen several stories. It struck him on the back of the head, neck and left shoulder. He awoke in another hospital three hours later and was unable to move the left arm or feel anything in it. For three days he was unable to see with the left eye. On the fourth and fifth days he bled a small amount from the left ear. He complained of pain and stiffness in the neck and was unable to flex his head forward. There was some weakness of the left leg which was not present on his admission to the Jefferson Hospital.

Physical Examination.—*Head, scalp, eyes, ears* and *nose* negative. *Face.*—Slight left-sided weakness. *Neck.*—No pulsations or enlarged thyroid present. Posterior cervical glands enlarged. Fifth and sixth cervical and first dorsal spines are tender. Rotation of neck painful to some extent. Flexion of head and neck limited. *Thorax.*—Expansion free and equal, though he complains of pain around the left clavicle on inspiration. Percussion note clear throughout. Breath sounds clear, vesicular. No râles. Practically the whole of the thorax is tender on pressure. No fracture of ribs demonstrable.

Extremities.—*Legs.*—Left knee slight contusion. No evidence of other injury. Power in left leg slightly decreased. Reflexes on both sides diminished. No Babinski or clonus. Sensation unimpaired.

Arms and Shoulders.—Right side, reflex normal. Slight tremor of fingers. Power and sensation unimpaired. *Left* side, paralyzed and anæsthetic; extending up whole arm

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to line of axilla. Tenderness over scapula muscles and extreme tenderness in axilla and above clavicle. Reflex absent. Paralysis of all of the muscles of the shoulder girdle.

X-ray Report December 20, 1924.—No evidence of fracture of the lumbar column or dorsal column. First rib on the left side may be disarticulated with the vertebræ, if the injury was in that region. No definite X-ray evidence of fractured skull. Antero-posterior view shows no fracture of cervical vertebræ.

Examination by Doctor Gilpin, December 26, 1924.—Reflexes are diminished but not absent in left forearm. Cannot explain loss of sensation and the presence of reflexes on organic basis. Will see patient again. Electrical reaction will be of great aid in diagnosis.

January 2, 1925.—Patient has loss of reflexes in paralyzed arm. No return of sensation over entire arm and hand. Very tender to pressure over brachial plexus.

January 9, 1925.—No return of sensations since last examination. Muscle atrophy taking place.

February 1, 1925.—Reaction of degeneration present.

Operation, February 14, 1925.—Incision exposing the roots and brachial plexus. The sheath of plexus opened. At the outlet of the spinal roots of the fifth, sixth and seventh cervical nerves, there was a definite cystic area; this was opened and there was an escape of cerebrospinal fluid. An attempt was made to find the proximal ends, but this was unsuccessful. The eighth cervical and the first dorsal roots were intact but the remainder of the plexus was a mass of inflammatory tissue. Neurotomy was done on all of the roots and trunks above and below the clavicle (which was divided at operation). The distal ends of the outer cord were implanted into the inner cord. Incision was closed with drainage. Fluid sent to laboratory (cerebrospinal).

Progress.—Patient made an uneventful operative recovery. Sensation returned in the arm down to the hand in the course of three months. There was some return of power to the muscles of the shoulder girdle but no return of power in any of the muscles of the arm, forearm or hand. *Discharged* March 14, 1925. Slightly improved.

Comment.—Patient was treated for one week in another hospital. He was then discharged with the diagnosis of hysteria. Too much time was wasted in waiting between the injury and the operation. Recall, Doctor Gilpin reported that reflexes were present in the forearm two weeks after the injury, but reflexes were absent at the time of operation, consequently, inflammatory changes, as a result of hæmorrhage and fibrosis, destroyed the remaining intact nerves.

The arm was amputated nine months after primary operation to settle a law suit. He now has good use of the shoulder girdle muscles (January, 1930).

CASE II.—*Brachial Palsy.* H. S., white male, aged forty-two years, H–10356, admitted to Jefferson Hospital April 1, 1929.

Chief Complaint.—Loss of use of right arm. Tingling sensation in fingers and arm.

Present Illness.—Patient states that on March 24, one week before admission to the hospital, while crossing the street, he was struck a glancing blow by an automobile. The impact of the blow knocked him down but not unconscious. He got up, brushed his clothes and proceeded on home and went to bed. On awakening about noon he noticed that he had been sleeping on his right arm. The arm felt numb and heavy and he was unable to use it. He noticed there was some slight pain in the base of the neck on the right side. He called his physician that afternoon who referred him to the hospital. Patient went to a hospital where he had electrical and heat therapy but without improvement. During the past week the sensory sensations have returned somewhat, but there has been no return of motor power.

Physical Examination.—Neck.—There is a swelling at the base of the neck on the right side, extending posteriorly. *Extremities.*—Reflexes normal in all but right arm. No clubbing, no œdema. Right upper extremity is flaccid. Patient has no power in

muscles below shoulder. Some sensation is present down the entire arm and hand, except on the finger-tips. Reflexes absent.

X-ray Report, April 3, 1929.—No X-ray evidence of abnormality of any of the bones of the right shoulder and there is no evidence of abnormality of any of the lower four cervical vertebræ on the antero-posterior exposures. No satisfactory film of the dorsal bodies. There are numerous calcified tubercles in the upper portion of the right lung.

Operation, April 13, 1929.—The sheath of the brachial plexus was opened, the plexus exposed from the roots to the clavicle. The nerves were not divided but were hard and fibrous. Definite hæmorrhage was present in the sheath. *Procedure.*—Each trunk and branch of the plexus was inspected and found to be fibrous. In some of the trunks there was definite evidence of recent hæmorrhage. Neurotomy was done on almost every nerve trunk and branches above the clavicle. The incision was closed without drainage.

Progress.—April 14, 1929.—Twenty-four hours after the operation, the patient was

Fig 1 —Case II. Shows return of function following neurotomy of the roots and trunks of the brachial plexus above the clavicle. (The paralysis was due to intra-neural and extra neural hæmorrhage.

able to move the fingers with the exception of the thumb. One can feel an attempt at flexion of the tendons of the arm.

April 15, 1929.—Patient was able to feebly abduct and adduct thumb. There is motion in all of the fingers. He complained of excruciating pain in the arm, for which morphine was required.

June 7, 1929.—Discharged, improved.

January, 1930.—There is some limitation of flexion and extension of the fingers. He cannot entirely extend the wrist.

Comment.—Early operative intervention was followed by an almost unbelievable return of motion in the paralyzed arm (twenty-four hours).

CASE III.—*Brachial Palsy, Left Arm.* F. H., white male, aged nine years, R–3073, admitted to the Jefferson Hospital August 24, 1928, four years after the injury.

Chief Complaint.—Complete motor paralysis of left hand, arm and muscles of the shoulder girdle. Total loss of sensation below the axillary fold.

Present Illness.—Four years before admission to Jefferson Hospital he was struck by an automobile.

Examination of Left Arm.—Complete palsy of all of the muscles of the left upper extremity. There is a suggestion of slight rotation (internal) of the head of the humerus. Sensation is lost below the upper third of the arm (humerus) on the outer side and below the lower one-third of the inner side. Sensation is present above these regions.

The muscles over the scapula, supra-and infra-spinatus and teres minor are atrophied and the serratus magnus left and pectoralis major left are also atrophied so that the left ·chest is flattened. He has no sensation to heat, cold or pin over left arm except in upper third internally. Sensation is not absent over the scapula area.

September 30, 1928.—Examination by Doctor Rugh. This case presents two phases, one, a possible anterior poliomyelitis with loss of sensation (a rare complication) and, second, traumatic avulsion, of nerve trunks, nerve roots or destruction of nerve cells.

October 5, 1928.—Examination by Doctor Strecker. Traumatic brachial paralysis. Reaction degeneration is complete in left arm.

October 9, 1928.—Examination of eye grounds under homatropine by Doctor Heed. R. E., media clear, disc slight pallor, margins not sharp, depression but no lamina. Capillaries rather over-full. Retinal vessels appear healthy. No gross lesion of retina or choroid. L. E. similar. Diagnosis.—Suggestive of an old neuritis of both eyes. No pressure signs at present.

October 16, 1928.—Examination of pupils by Doctor Heed. R. E., 7 millimetres, L. E., 5 millimetres. Both react promptly to light and convergence. The inequality I believe is due to irritation of the cervical sympathetic.

Operation December 22, 1928.—Incision exposing the brachial plexus, the sheath opened. A definite hæmorrhagic cyst was present involving all of the cords of the plexus. The outer cord was avulsed at the roots. After careful dissection with a sharp knife some of the fibrosi were removed, the cords and nerves were hard, firm and shrunken in size. The end of the divided outer cord was freshened and implanted into the posterior cord and sutured with catgut. Neurotomy was performed on trunks and branches of the plexus. The incision was closed without drainage.

Progress.—The child remained in the hospital for a number of months and was discharged unimproved. He was followed in the out-patient department for six additional months. There was no evidence of improvement in muscular power of the arm; although he had attacks of pain which reached the palm of the hand. No further progress, if this one slight manifestation could be considered progress. We advised the mother of the child to have the paralyzed arm amputated. This she refused. In January, 1930, there were no trophic lesions present. He was able to shrug his left shoulder and pull his arm toward the chest. He had more frequent attacks of pain down the arm to the palm of the hand. There was no other improvement in the arm.

Comment.—The records of the first hospital where the child was taken state: "Patient has about one-third normal motion of the injured arm. There is slight sensation throughout the entire arm." Four years after this, Doctor Strecker reports a total brachial plexus paralysis. This is something for the advocates of the conservative plan of treatment to think about. Again recall the findings at the operation, a hæmorrhagic cyst and a divided outer cord, both conditions amenable to operative procedure. Compare the results in this case with those of Case II, in which case there was sensation in the arm but no muscle power, yet, the case report of No. II shows at operation, done two weeks after the injury, "hæmorrhage in the plexus." The patient was able to move his fingers barely four hours after the operation. There is no doubt, as you gentlemen can observe, that this child operated upon four years after the injury, can shrug his left shoulder and has some power to abduct the arm. Previous to the operation he was unable to perform either of these movements in Dr. J. Chalmers DaCosta's Clinic or when Doctor Rugh presented him before the Orthopedic Society.

CASE IV.—*Avulsion Brachial Plexus. Right Arm.* A. C., white, male, aged thirty-seven years, O-10911, admitted to the service of Dr. J. Chalmers DaCosta, Jefferson Hospital, April 26, 1926.

Chief Complaint.—Inability to use the right arm.

Present Illness.—January 10, four months ago, while walking along a bank, he stepped off a wall, falling a distance of about fifteen feet striking his right shoulder and head. He was unconscious for about an hour. On regaining consciousness in the house of a friend, the right arm was paralyzed. Six weeks later when the bandages were removed from the arm, there was no improvement.

Physical Examination.—*Chest.*—Negative with the exception of prominence of the right

scapula and wasting of the muscle in this region. The right shoulder is lower than the left. Extremities.—Reflexes normal in the left arm and both legs. No œdema or tremors. Right arm hangs uselessly at his side when removed from the sling. There is total paralysis of the shoulder girdle muscles and complete sensory loss of the entire right arm and hand.

X-ray Report.—There is decalcification of the right acromion process in the region of the glenoid and of the right humerus in the region of the surgical neck and the greater tuberosity. There is no evidence of fracture or dislocation to account for this change; it does not seem to be the result of infection because there is no appreciable swelling in the soft parts. The left shoulder is apparently normal. There is no X-ray evidence of injury of any of the lower nine dorsal or upper two lumbar vertebræ. There is a synotosis between the sixth and seventh ribs in the paravertebral line.

FIG 2 —Case IV Showing the return of power in case of complete right brachial paralysis Operated upon four months after injury.

Neurological Examination.—R. D. is present in all of the muscles of the right shoulder, arm and hand.

Operation May 8, 1926.—Incision exposed the brachial plexus, the sheath of which was opened; the plexus was obscured by a mass of scar tissue due to organized blood. It was almost impossible to isolate any definite nerve trunk because of the scar tissue. The fifth and sixth cervical trunks were finally identified and freed from scar tissue. Neurotomy was done on each of these nerves down to their subdivision. An end of a divided trunk, which they took to be the inner cord (the seventh cervical nerve) was freed from scar tissue. They were unable to find the proximal end of this trunk, so they implanted the distal end in the posterior trunk, after making numerous slits in the posterior trunk by means of a small cataract knife; "O" catgut was used to suture the distal end of the seventh nerve into the posterior trunk. Because of their inability to positively identify the structures and the uncertainty of where the implant was placed, an unfavorable prognosis was given to the family.

May 29, 1926.—Discharged. On day of discharge, three weeks after the operation, the patient had some movement in his right hand and some return of sensation. He complained of shooting pains down the arm and hand.

October 15, 1928.—*Two years later.* Patient re-admitted to Hospital with subacute appendicitis and post-operative brachial palsy.

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Examination of Arm—Left side normal. Right upper extremity: patient cannot abduct the arm or bring it posteriorly. He is able to draw the forearm forward weakly over the right chest. He cannot rotate it at the shoulder. Flexion power is absent. Also extension of forearm absent. He can pronate and supinate the hand.' He has good flexion of the hand but extensor power is absent. Flexion of thumb and index finger normal. Remaining three fingers have moderate flexor power but can be only half extended. Hand grip fairly strong. Lifting power of hand and arm strong. Crepitation of right shoulder joint present on movement of shoulder. The patient can distinguish between sharp and dull over the entire extremity except in an area over the radial side of the forearm, extending from the elbow to the base of the thumb. In this area he has a constant "cold numb" sensation. Heat and cold tests normal excepting radial surface of forearm, bases of thumb and index finger—here the sensation is confused.

FIG 3 —Case V. Shows bullet in the sixth cervical vertebra causing paralysis of the left arm

October 17, 1928.—Electrical reaction. R D. is present in the biceps muscle. In all other muscles of arm R. D. is not present.

Comment.—This patient was again seen in October, 1929, three and one-half years after the operation. See Fig. 2, Case IV. Sensation is practically normal throughout the right upper extremity. All functions of the arm and hand have returned except flexion of forearm. There is still weakness of the extensors of the wrist, but wrist drop is not present.

This illustrates the long interval between the injury and operation (four months). Some early return of muscle power, three weeks after operation, in muscles in which the electrical reactions of degeneration were present at time of the operation. It further emphasizes the protracted period (two years) before any marked improvement in muscle power was evident, and lastly, the amazing strength of the muscles and the complete return of sensation which occurred in the third year after operation.

CASE V.—*Left Traumatic Brachial Palsy, Due to Bullet Imbedded in Sixth Cervical Vertebra.* P. A., white, male, aged twenty-two years, R–9749, admitted to Jefferson

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Hospital March 11, 1929. *Chief Complaint.*—Inability to use left arm. Sensory changes in dorsum of left hand.

Present Illness.—On the night of February 2, 1929, a .38 calibre bullet was inadvertently lodged in neck. He immediately lost the use of the left arm and left leg. Power in the leg began to return two days later. The use of the arm, however, did not return; on the contrary, the slight flexion use he had, at the elbow, was lost. He attributes this to an attempt of removal of the bullet at another hospital. This, of course, was not the case as only a superficial attempt was made to remove the bullet.

Physical Examination, March 11, 1929.—Five weeks after the injury. There is no loss of power or sensory loss in either leg. The reflexes are normal. There is a flaccid paralysis of the left arm, from and including the shoulder to the wrist. He can just move his fingers toward flexion; adducting and abducting function is lost. There is no complete sensory loss in the arm or hand except on the dorsum of the hand.

X-ray Findings.—There is an irregular triangular body, metallic, which is probably a .22 calibre bullet and which was mushroomed. It overlies the spinous process of the sixth cervical vertebra. It is laterally on the left side. There has apparently been some injury to the body of the vertebræ at the point of intact on the posterior aspect · of the body.

Fluoroscopic examination on March 15, 1929, confirmed the above report.

Operation March 23, 1929.—An incision exposing the brachial plexus was made. There was no external evidence of trauma to the plexus. The sheath was not opened. The spinal column was reached across the posterior triangle of the neck. Dr. John Farrell localized the bullet lodged in the body of the sixth cervical vertebra and making lateral pressure on the spinal cord, the bullet was removed under the fluoroscope.

Progress.—The patient made an uneventful operative recovery. Sensation rapidly returned to the hand and the tingling, burning feelings abated. In two weeks he could flex, extend and abduct the fingers. In one month he could flex and extend the elbow. In six months he was able to write.

Comment.—This case represents trauma to the roots within the spinal cord. Fortunately, the roots were not divided. This case further shows definite spinal cord trauma, manifested by paralysis of the left leg for three days after the traumatism. During the seven weeks elapsing between the time of the injury and the operation, muscle power was being lost and not regained. It will be recalled that immediately after the injury he could flex his arm at' the elbow, but three days later, he could not.

CASE VI.—*Gun-shot Wound of Axillary Plexus.* G. M., white, male, aged twenty-eight years, R–5285, admitted to Jefferson Hospital October 25, 1928. *Chief Complaint.*—Paralysis of left arm, burning sensation in fingers of left hand. Pain in left arm from elbow to hand.

Physical Examination.—Head.—Eyes.—Left pupil smaller than right pupil. Both react to light and accommodation. Ciliary reflex present. L. int. Rectus muscles possibly a little weak. *Surface of Chest.*—A puncture wound in the first interspace just lateral to the M. C. L. A second gun-shot wound on the summit of the shoulder, midway between the base of the neck and the tip of the shoulder. *Extremities.*—The left arm hangs limply to the side. He is able to weakly rotate the shoulder anteriorly and posteriorly. All other movements of arm, forearm and hand are lost, except abduction and adduction of the thumb (very weak). Some flexion power of the first and second phalanges of all of the fingers.

Sensation.—There is a gradual diminution of tactile sensation from the elbow to the hand; on the floor surface of the mid-radial region there is a small area of anæsthesia; on the floor surface of the thumb and index finger, tactile sensation is lost.

October 29, 1928.—Examination by Dr. Wm. Schmidt. Examination of arm shows complete R. D. in all of the muscles of the arm except the flexor muscles of the hand.

Operation October 30, 1928.—Incision exposing the axillary plexus by dissecting the pectoralis major muscle. A through and through gun-shot wound divided the

musculospiral; the median, musculocutaneous and circumflex nerves were traumatized but not divided and imbedded in scar tissue. The artery was not damaged. The scar tissue dissected from the nerves, neurotomy was done through the scarred area, the musculospiral nerve was anastomosed. The incision closed, a small rubber tissue drain introduced in the superficial parts.

December 20, 1928.—Discharged.

Comment.—Within one week following the operation the pain in the arm and hand had to be controlled by morphine; aside from this symptom, the progress in this case was slow. There was a gradual increase in the muscle power of the flexor group, so, that on discharge from the hospital, sensation, ten weeks after operation, was decidedly improved and he had a fair grip. During the subsequent six months, there was a gradual return of function of all of the muscles of the arm except the extensor group. The patient carried his hand in a Jones cock-up splint during this period, and he was given massage. He was not given electricity as it was unavailable in his home town. One year after the operation, he was again seen. He has extensor power returned. He drives his car and carries on his routine work.

CASE VII.—*Fracture of Cervical Vertebræ, Brachial Neuritis.* J. D., white, male,

FIG. 4 —Case V. Shows use of fingers after removal of the bullet from the body of the sixth cervical vertebra.

aged fifty-six years, O-3672, admitted to Jefferson Hospital November 1, 1925. (Professor DaCosta's service.) *Chief Complaint.*—"Stiff neck," pain and weakness in left arm.

Present Illness.—On October 27, 1925, patient, while at work, accidentally slipped and fell down about eighteen steps (wooden) hitting his head many times on the way down. The following day his neck was stiff, swollen, and painful, especially when he attempted to move his head. He noticed at times his inability to use arm but he attributed this to the excruciating pain in the arm which had been diagnosed as neuritis, because of sudden, sharp pain at onset, which has been more or less continuous since the accident.

Physical Examination.—*Eyes.*—Pupils irregular. Right pupil larger than left. Right pupil appears the more normal. No evidence of muscle inbalance. No conjunctivitis. Sclerotics a little injected.

Neck.—Rigid. Patient turns head on axis of body. No extreme rigidity of muscles of neck. Tenderness upon pressure over sixth to seventh cervical vertebræ. No palpable thyroid enlargement. No abnormal pulsation.

Chest.—Prominence of right side. Expansion fairly equal. Resonance throughout

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except somewhat impaired at right apex posterior. Bronchial breathing right apex posterior. Tactile fremitus and vocal resonance increased on right side posterior except at base. Breath sounds generally clear elsewhere throughout. Occasional friction fremitus at left lower axilla.

Extremities.—Left arm and shoulder-joint. There is a point of tenderness about the size of a dime above the clavicle in middle which, upon pressure, causes referred pain down the outer side of shoulder, arm and forearm to finger tips. Upon direct pressure outer side of arm and forearm is "numb" to sensation; also palmar and dorsal aspect of fingers and thumb. Tenderness over mid-portion of spine of scapulæ. Pain referred down left arm when moving shoulder and elbow-joint. Left forearm thinner than right. No palpable axillary epitrochlear or supraclavicular glands. Radial pulse of good volume, regular in rate and rhythm and compressible.

X-ray Report, November 10, 1925.—There is a fracture of the posterior arch of the second cervical vertebræ with slight anterior subluxation of the second cervical vertebræ. There is evidently no lateral displacement. There is no evidence of tuberculosis in the chest nor any other pulmonary lesion.

Examination by Doctor Strecker, November 17, 1925.—The left upper forearm and hand show weakness and there is a considerable degree of atrophy which is especially noticeable in the forearm. The left arm is smaller than the right in all its dimensions, it is somewhat hard to believe that all the atrophy could have occurred in three weeks. The patient gives a history of fracture of shoulder five years ago and some of the atrophy may be due to this. The pain he describes is probably root pain and there is hyperæsthesia of the left upper extremity to pain stimulation. Probably there is some cord pressure.

December 5, 1925.—Discharged.

Comment.—This case was included in this series to emphasize the importance of ciliospinal reflex in cervical cord lesions. Had this been observed an earlier diagnosis would have been made. This case also emphasizes the rapid wasting of muscle. Observe Doctor Strecker's report! It is difficult to believe that all of the atrophy could have occurred in three weeks. Furthermore, had this case been diagnosed early and treated by the conservative plan, the rapid improvement which took place would have been credited to the conservative plan of treatment. The cause of the symptoms and signs was cord pressure, not brachial avulsion or traumatism. We are led to believe that some of the rapid cures by the conservative plan of brachial traumatism (not birth), belong in this group of cases.

THE CAUSE AND ELIMINATION OF REACTIONS AFTER INTRAVENOUS INFUSIONS*

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The history and application of intravenous therapy and medication especially as to the use of saline, glucose and acacia solutions has been completely and well reviewed in a recent article by Norman Keith of the Mayo Clinic. The value of infusions has generally become well accepted, but their effectiveness is often marred by untoward reactions, often at most inopportune times. It is the purpose of this paper to clear up the causes of these reactions and demonstrate practical methods to eliminate them. Reactions, as we know them, embody a variable extent of damage to the body physiology from mere elevation of temperature to chills, cyanosis, diarrhæa, nausea, vomiting, collapse and death. Even the mildest are uncomfortable to the patient and severe reactions are always dangerous, especially so in very ill cases, which are often, incidentally, the very cases wherein intravenous therapy can be of greatest value.

Many things have been suggested as causes for reactions, and to comprehensively study the problem each of the suggested factors was considered and either proven or disproven to be active factors in the situation. Thus rubber tubing, heat of solution, speed of injection, individual susceptibility, disease itself, hydrogen ion concentration of solution, absorption from glassware—all these have been suggested as possible causes. Of these, the first and seemingly most likely factor to be studied was the effect of hydrogen ion concentration. A portable quinhydrone unit was designed as illustrated (Fig. 1) using a Micslowitzer quinhydrone cup against standard saturated calomel electrode, and a Leeds and Northrup potentiometer. The temperature coefficient was placed on a graph in the top of the box so that readings made after equilibrium of the solution could be directly transposed to p^H and corrected for changes in temperature. This method gave readings of comparatively great accuracy within a few minutes' time. The accuracy of the method was challenged, however, because the solutions studied were unbuffered. It was therefore carefully checked with a colorimetric method, using brom-thymol blue. Fig. 2 illustrates in graphical form the result of this check. It is to be noted that there is an average variation of some 0.25 p^H between the two methods. This is, however, constant, and "salt action" of the indicator used in itself introduces a possibility of error, so that the true p^H probably lies somewhere between the two. We feel that the quinhydrone method is much the more accurate for relative differences of p^H and the observations made are therefore recorded in quinhydrone figures.

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* Read before the Philadelphia Academy of Surgery, April 7, 1930.

The actual results as determined by carefully checked readings in some fifty-five infusions suggest strongly, with but one exception, that salines of
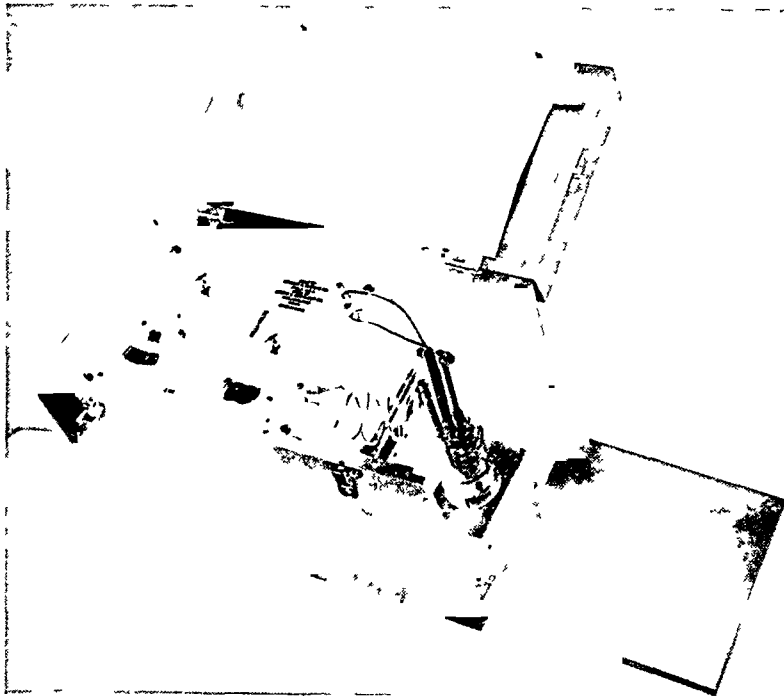

FIG 1 —A portable Quinhydrone p^H determinator

alkaline p^H are more prone to give reactions. It is to be noted (Fig. 3) that the line of division lies at a p^H of 7.05. By this means we were able to classify solutions used as pyrogenic, or reaction-giving and non-pyrogenic, being careful not to use solutions near the border line of p^H. Later only
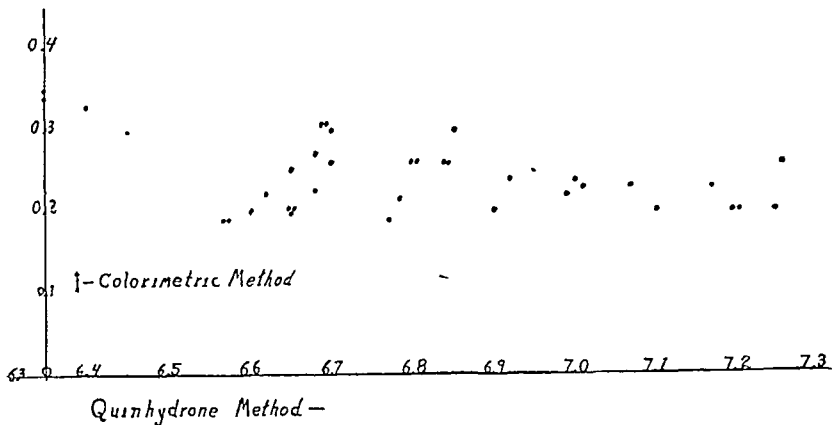

FIG 2 —Check of Quinhydrone method

water proven physiologically was so classified. That p^H in itself is not a causal factor was proven by buffering a solution of high p^H or pyrogenic, to a lower p^H, only to still have reaction occurring. Addition of ammonia to solutions of low p^H or non-pyrogenic caused no reactions, although the final p^H was over 8. The p^H of absolutely pure water, calculated from its dissociation constant,

should be 7.0, and the fact that solutions when freshly boiled, having p^H higher than this cause reaction suggested strongly that alkaline impurities might be the causal factor, and this suggestion in turn led to chemical analyses of distilled water, which will be discussed later.

Individual susceptibility has been much discussed as cause, and this was next considered. A series of patients were given several infusions on sepa-
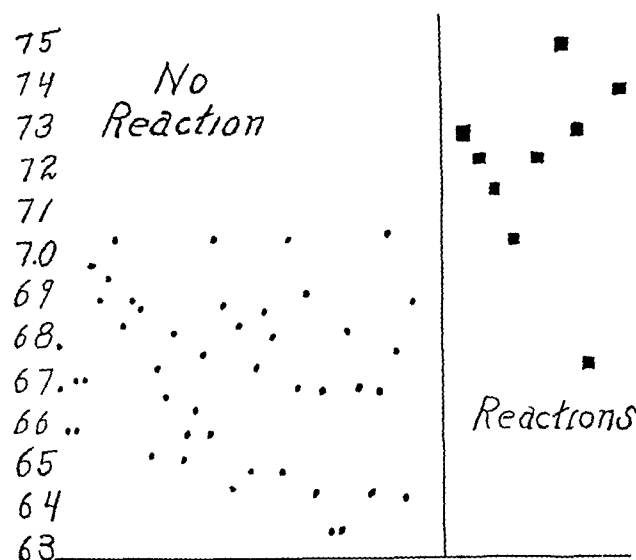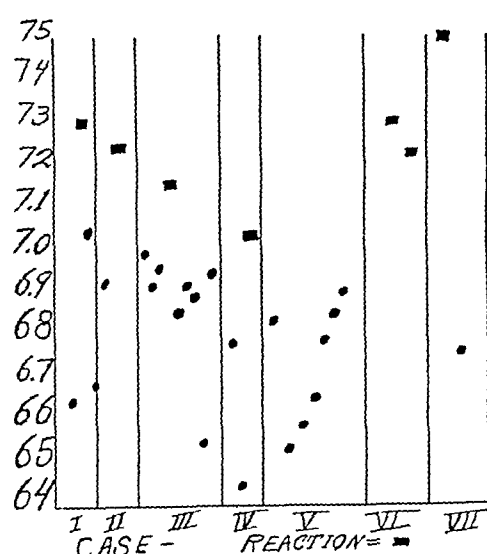

FIG 3—Reactions and p^H. FIG 4—Individual susceptibility.

rate days or twice a day. Graphically illustrated Fig. 4 shows that each patient can react differently to various infusions, and not constantly in the same manner. It is also to be noted that the same p^H indicator is still present in this series. Later work by injection of the true causal factor does show a slight variation of individual susceptibility to the chill-producing agent, but certainly not enough to explain the reaction itself.

TABLE I

Effect of Disease

Disease	Reaction	No Reaction	Percentage
Acute gall-bladder	4	11	36 3
Peptic ulcer	5	5	50 0
Sigmoiditis	1	7	14 0
Acute infection	1	1	50 0
Peritonitis....	1	6	16 0
Miscellaneous	1	13	7 0
Totals	13	43	30 2 (Ave.)

Types and severity of disease were next suggested. Table I shows the inconstant percentages of reactions in five diseases, and one cannot help but conclude that disease is not a specific factor, since reactions occurred in all types. There is, however, a suggestion that severity of disease may increase susceptibility.

Rubber tubing was next ruled out by giving non-pyrogenic solutions through fresh rubber tubing, by boiling solutions with fresh rubber corks so that the final solution smelled strongly of rubber, all of which produced no reaction. Many of the above infusions, both with and without reactions, were, moreover, given through the same tubing.

The chill-producing effect of glucose and sodium chloride, per se were next ruled out. Glucose of many lots and of various manufacturers were used, either prepared in distilled water, or given with saline, or in concentrated form, from ampoules. The latter never gave reactions, and the absence or presence of reactions in the former methods was entirely inconstant. Many reactions have also been observed following infusions of saline without glucose. Once more an accusing finger seems directed to distilled water, which was absent in concentrated ampoules. Both buffered and unbuffered solutions were used, but no differential result could be noted.
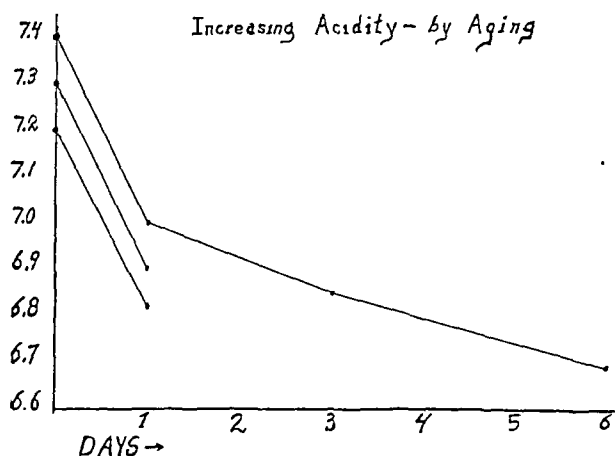

FIG. 5.—Effect of aging of solutions.

Temperature of solution has been much emphasized and many appliances are on the market now to keep up the temperature of infusion solutions. Non-pyrogenic solutions were given at 20° C. and at 110° F. without producing reactions. When too hot the patient complains of burning at the site of injection, but no reaction occurs. On the other hand, administration of cool fluids to patients with high temperature often has seemingly caused a drop of body temperature without reaction or chill. It is to be noted also that all the infusions above tabulated were given as near body temperature as possible, yet reactions occurred. The work of Swale Vincent may be cited here, but the reactions observed by him were those affecting blood-pressure, and no mention was made of other reaction.

Speed of injection is another possible cause emphasized by many who say that slow injection will prevent reactions from occurring. Non-pyrogenic solutions given at the rate of 1000 cubic centimetres in ten minutes through a large-bore needle gave no reaction. Pyrogenic solutions given at a rate of 1000 cubic centimetres per hour produced their usual reactions.

With the ruling out of all these extraneous factors and the constantly appearing suggestion of alkaline impurities as a causal factor, attention was next centered upon the nature and amount of that possible impurity and a careful study was made of distilled water. The p^H of distilled water was found to vary from 5.9 to 7.3 in examination of twenty-five bottles. Making up into saline did not change the original p^H, but fifteen minutes' boiling in

the autoclave caused a rise of p^H from 0.2 to 1.0 in various samples. This p^H after boiling rapidly fell at a definite rate, as illustrated in Fig. 5. This fall has no effect on reactions, since the solution of high original p^H still gave reaction at the low level illustrated. Reboiling will bring the p^H back to the original. Sterilization excludes the action of bacteria or their products as cause of this drop on aging. Its rapid occurrence and ready reversibility lead one to believe that this is purely a chemical absorption of gases, probably carbon dioxide from the air. The p^H in boiled solutions causing reactions suggests, however, the presence of an alkaline, non-volatile substance as causal factor, and analysis of distilled water was undertaken.

Two samples were used, pyrogenic (p^H 7.5) and non-pyrogenic (p^H 6.7) whose properties were proven physiologically to be such. Table II shows the differential analysis. Total solids were analyzed by evaporation at low temperature in platinum dishes until dryness. The inorganic fraction was determined by flaming to white heat, and the organic calculated by the dif-

TABLE II

Differential analysis

	Pyrogenic		Non-pyrogenic	
p^H	7.5		6.7	
Total solids	3.4	mgm/L	3.2	mgm/L
Organic solids	2.2	mgm/L	1.2	mgm/L
Ammonia	0.69	mgm/L	0.34	mgm/L
Inorganic solids	1.2	mgm/L	2.0	mgm/L
Ammonia content (distilled)				
First fraction	0.532	mgm/L	0.157	mgm/L
Residue	0.159	mgm/L	0.181	mgm/L
Bacterial count	150,000	per L.	550,000	per L.

ference. Organic content was again checked by a rather rough titration with permanganate and its reduction on heating. Ammonia was determined by a modified Nessler method. The greater amount of combined ammonia and organic matter in the pyrogenic water is to be noted especially. The first fragment of pyrogenic water distilled at 105° C. shows a considerable amount of ammonia. At this temperature precipitation occurs of a brownish, gelatinous material, and ammonia is driven over, showing the unknown compound to be split at 105° C.

Because of this, some pyrogenic water was distilled under vacuum at 35° C. No water trap was in the system and the first fraction when injected into a dog produced severe reaction. The middle fraction was non-pyrogenic, but the residue gave severe sustained fever without great chill. This is illustrated in Table III. Bacteria then attracted our attention and plating revealed the huge numbers of bacteria shown in Table II. The greater number was, however, present in the non-pyrogenic water and it was our intention to study the various types of bacteria and their products when the papers of Dr. Florence Seibert and her colleagues were discovered. All the results so

TABLE III

Reactions in dogs

Substance	First fraction	Second fraction	Residue
Pyrogenic water	++ 18 cc.	— — 150 cc.	++ 19 cc.
Non-pyrogenic water	— — 5 cc.		— — 5 cc.
Non-pyrogenic N.S.S.	— —		
Non-pyrogenic N.S.S. and ammonia	— —		

far described corroborate in every detail the work reported by Doctor Seibert during her years of study of this problem. Thus even fractional distillation revealed the same results, except that she was able to eradicate the pyrogenic property of the first fraction by use of a water trap, as illustrated in Table IV.

Her work continued farther, however, in that she isolated the bacteria as belonging to a group of river bacteria classified in Jordan's classification as Groups X and XI. She definitely and conclusively proved that reactions were caused by the toxic products of these bacteria and not the bacteria

TABLE IV

Dr. Florence Seibert

Original water	First fraction	Second fraction	Residue
++	++	— —	++
+	+	— —	++
	Water trap interposed		
++	— —	— —	++
++	— —	— —	— —
++++	— —	— —	++++

themselves and showed how easily water could be contaminated by them. These experiments have been repeated by us with essentially the same results.

It is of interest to note that the quantity of pyrogenic water necessary to produce reaction may be very small, since ten to one hundred cubic centimetres may easily give a severe reaction as demonstrated by Doctor Seibert and corroborated by us in a series of cases. Pyrogenic substances can occur in forty-eight hours after contamination, unless the water be first sterilized to prevent growth of organisms. Moreover, only the most efficient of spray traps will prevent the first fraction causing reactions, as we have shown in a recent series of infusions.

Practical application of these combined results is simple and easy. Single distillation by a suitable apparatus, preferably a still containing a multiple Baffle Plate spray catcher, or Glinsky tube, with immediate sterilization and absolute seal will make solutions permanently reaction-free, unless the seal is broken. The essential feature to be stressed again and again is the necessity of water-trap distillation, to prevent mechanical carrying over of toxins, and immediate sterilization and seal to prevent growth of bacteria. Triple dis-

tillation is not essential if the above precautions are carried out, but they must be carried out accurately and carefully since the tap water used for distillation contains much of the pyrogenic substances and any flaw in the above mechanism, either in inadequate apparatus, or delay in sterilization, will nullify all other efforts or precautions taken to prevent reactions. It is the hope of the author that by bringing these facts more definitely before our clinicians that reactions following intravenous infusions may become a thing of the past.

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HYPERPARATHYROIDISM

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FROM THE MAYO CLINIC

Since the discovery of the parathyroid glands by Sandström, in 1880, an occasional case of parathyroid hypertrophy or tumor has been reported in patients with osteomalacia, osteitis fibrosa, paralysis agitans, rickets, tetany, chronic nephritis, and epilepsy. DaCosta, in 1909, could find only seven cases reported in the literature. He added one more. In five of these the condition was found incidentally at necropsy; three were operative cases but did not present pathognomonic features. Hoffheinz, in 1925, reviewed pathologic reports of forty-five cases of enlarged parathyroid glands. In twenty-seven of these, there was disease of the skeleton (osteitis fibrosa, seventeen; osteomalacia, eight; and rickets, two). Lloyd, in a recent review of 10,000 consecutive necropsies, found five parathyroid tumors. As early as 1903, Erdheim commented on the frequency of the occurrence of the combination of the foregoing diseases of bone and parathyroid tumors. He advanced the hypothesis that the parathyroid enlargement might be an inadequate attempt at compensatory organic hypertrophy effected by the pathologically disturbed calcium metabolism. On the basis of this, Mandl, in 1925, transplanted healthy parathyroid glands into a patient with generalized osteitis fibrosa, but this had no effect on the progressive course of the disease. He then explored the region of the parathyroid glands and removed a parathyroid adenoma. Following this, the patient spectacularly improved. This led Mandl to conclude that in some cases, at least, the parathyroid tumor is primary and the bony changes are secondary. Nine cases have been reported with some or all of the features of the syndrome which Barr, Bulger, and Dixon called hyperparathyroidism. In five of the nine cases, operation was performed and tumors were removed. In one case of the nine, two apparently normal, but undoubtedly hyperfunctioning, parathyroid glands were removed. Three patients were not operated on and there is no proof of the presence of tumors, but many of the clinical features were present.

The clinical features to be noted in general are (1) high concentration of serum calcium; (2) low concentration of serum phosphorus; (3) abnormal excretion of calcium in the urine; (4) rarefaction of bones; (5) occurrence of multiple cysts or tumors of bones; and (6) hypotonia and muscular weakness. A negative calcium balance might properly be included. since in every case in which studies of excretion of calcium and phosphorus were done. a negative calcium balance was found, except in the case of Wilder's patient. In this instance the determinations were done several days after the institu-

tion of a high-vitamine diet and daily exposures to ultraviolet light. This the author considered to be the cause of the slightly positive calcium balance found at that time. Following the removal of the parathyroid tumor these studies were repeated and huge amounts of calcium were found to be retained.

In the five cases of parathyroid tumor and the one case of hyperfunctioning parathyroid glands, the sexes were equally divided and the ages ranged from twenty-eight to fifty-six years, as far as is known. The age of the patient in the case reported by DuBois, Aub, Bauer, and Richardson's patient is not known. All the patients were weak, tired, and were either unable to walk or found difficulty in walking. All but one had pain. The pain was prone to affect the extremities. If the patients could assume the upright position, the posture was poor. Kyphosis, dorsum rotundum, and bow legs were to. be seen in various cases. Polydipsia and polyuria seemed to have some significance, although they were not constant symptoms. At some time during the course of the disease, frequently early, attacks of nausea, vomiting, and abdominal pain, associated at times with marked constipation, were to be noted. This was especially evident in the cases reported by Gold and by Boyd, Milgram, and Stearns. These attacks disappeared promptly on removal of the parathyroid tumor. Muscular weakness, hypotonia, and lassitude were noted in a number of cases, especially in the cases reported by Mandl, by DuBois, Aub, Bauer and Richardson, and by Barr, Bulger and Dixon. Rarefaction of bones was present in every proved case and in all but one of the unproved cases. This was always so marked as to be called osteitis fibrosa cystica on the basis of the röntgenograms. Fractures of these rarefied bones were reported in half of the cases. Multiple cysts or tumors of the bone were frequently encountered. Loss of weight was usually marked, and, in some cases, extreme.

In each of the five cases in which a parathyroid tumor was removed and in the one case in which hyperfunctioning parathyroid glands were removed, there was striking improvement in the clinical picture after the first few days. Usually, immediately after the tumor is removed, these patients show evidence of tetany. Immediately after operation the high concentration of serum calcium dropped to far below normal, and it was usually weeks before it gradually rose to within normal limits. In those cases in which metabolic studies of calcium and phosphorus were done after removal of the parathyroid tumors there was marked retention of both. In the case reported by Boyd, Milgram, and Stearns, there was a remarkably rapid and complete return to normal of the urinary symptoms and signs soon after the operation. The tumors removed in four of the cases were adenomas, and in one case the tumor was malignant. Wellbrock, in 1929, renewed the subject of malignant adenoma of the parathyroid glands.

Duken reported two of the three cases in which operation was not done. Both patients presented some of the features of hyperparathyroidism.

One patient died of generalized sarcomatosis some time after the original

report of the case was printed, and in the other case an operation was not done, so neither of these cases can be accepted as proved. Box and DeWesselow, in 1925, reported a case of "chronic nephritis with possible parathyroid syndrome." This case presented many of the features of hyperparathyroidism but the suspicion that a parathyroid tumor was present was not confirmed by operation or necropsy.

The case reported herewith is the seventh proved case of hyperparathyroidism and the sixth in which this condition was due to tumor. These cases record a remarkably complete and relatively new clinical syndrome. Based on knowledge of the physiology of the parathyroid glands, as recently demonstrated by Collip, by Greenwald and Gross, by Albright and Ellsworth, and by others, these cases represent exactly what one would expect if the body were subjected to an excess of the parathyroid secretion over a relatively long time. Albright and Ellsworth recently made complete studies on a young Italian boy whose condition they had diagnosed as hypoparathyroidism. The criteria on which this diagnosis was made were (1) low serum calcium; (2) high serum phosphorus; (3) cataract; (4) normal density of bones; and (5) aggravation of tetany by exertion. All of the cases referred to in this report demonstrate exactly converse changes.

REPORT OF CASE.—A girl, aged fourteen years, registered at The Mayo Clinic November 23, 1929. The chief complaint was of spells of vomiting, pallor, and loss of weight. She had always been healthy and robust until about sixteen months previously. In July, 1928, she had begun to be a little pale, to lose weight, and to be generally below normal physically. Her weight had decreased from eighty-six to fifty-five pounds from the onset of her trouble to the date of admission. Beginning in the summer of 1928 she had become constipated and had required cathartics until two months before her admission, when movements of her bowels had become, and had remained, fairly regular. October 4, 1928, she had had her first spell of vomiting. This had lasted twenty-four hours. During this period she had been unable to retain anything in her stomach. After that time, the spells had recurred at intervals of never more than two weeks and had lasted from one to five days. These attacks had seemed to appear without cause. Food did not act as a predisposing cause. Between attacks she could eat anything with impunity. The last attack had begun one week before her registration at the clinic and had continued five days. She had had polydipsia and polyuria, with consequent

TABLE I

Variations in blood serum calcium and phosphorus

Date, 1929	Calcium milligram in each 100 cubic centimetre	Phosphorus milligram in each 100 cubic centimetre
November 4	16.32	2.46
November 5	17.67	2.80
November 15	15.50	3.2
November 16	Operation	
November 18	7.89	2.2
November 25	7.74	3.41
November 29	7.56	3.9
December 5	7.85	4.04
December 12	10.36	3.57

nocturia three to five times each night for the preceding year. She consistently drank about two quarts of water each night.

The patient weighed fifty-five pounds, whereas the standard weight for her height and age was ninety pounds. She was pale, emaciated, and appeared to be chronically ill. Electrical irritability was decreased. Otherwise, the general examination gave essentially negative results.

Complete gastro-intestinal studies did not reveal organic lesions. The blood count revealed moderate secondary anæmia. Urine varied in amount from 750 to 3150 cubic centimetres; specific gravity, on daily examination varied from 1.004 to 1.010. The urine usually contained a trace or a faint trace of albumin and occasionally a few pus cells. Excretion of phenolsulphonephthalein on one occasion was 40 per cent. and on another 45 per cent. in two hours. The concentration of blood urea on the day of admission was 80 milligrams in each 100 cubic centimetres. The following day it was 37 milligrams in each 100 cubic centimetres and it never thereafter rose above 40 milligrams. In Table I are given the variations in the concentration of serum calcium and serum phosphorus during her stay at the clinic. Röntgenograms of all the bones gave evidence only of diffuse decalcification, without loss of normal structure of the bone (Figs. 1, 2 and 3). Repeated tests of water concentration were done, all of which disclosed definite fixation of specific gravity. Polydipsia or polyuria were not constant while the patient was under our observation. A study, for three days, of calcium and phosphorus in the urine and the stool revealed a slightly positive

FIG. 1.—Generalized rarefaction of femurs and tibias.

phosphorus balance and a slightly negative calcium balance.

In view of the similarity of this case to several of the other cases of hyperparathyroidism, a tentative diagnosis of parathyroid tumor was made, although careful palpation of the neck with this in mind did not reveal tumor in the parathyroid region.

November 16, 1929, operation was performed. The thyroid gland was found to be about normal in size, but it contained a little more colloid material than normal. Lying behind the left lobe of the thyroid gland at the inferior pole and outside of the capsule but attached thereto, was a tumor which measured 1.5, 1.25 and 1.25 centimetres in various diameters (Fig. 4). It was definitely brownish and the contrast in color between the tumor and remainder of the thyroid gland was marked. The color and situation of

the tumor indicated it to be an adenoma of the left inferior parathyroid body. The tumor was removed. Other parathyroid bodies could not be seen. The right lobe of the thyroid gland was elevated also and there was no tumor behind this. Nothing was done

FIG 2 —Generalized rarefaction of skull

FIG. 3.—Generalized rarefaction of pelvis

to the thyroid gland. Pathologic study of the tissue removed (Fig. 5) disclosed that it was a parathyroid tumor (adenoma) weighing 16 grains (1 milligram).

The effect of the operation was remarkable. The following day the patient complained of numbness and tingling in the fingers and toes, and Chvostek's sign was present

FIG 4 —Gross specimen of parathyroid adenoma Dimensions 1 5, 1 25 and 1 25 centimetres in various diameters
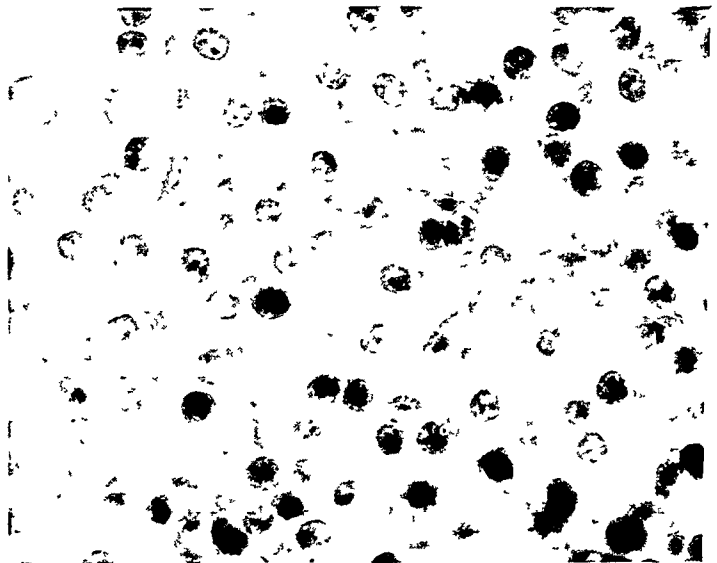
FIG 5 —Structure of parathyroid adenoma (× 750).

at irregular intervals for several days The tingling and numbness became worse, and November 19, 5 cubic centimetres of solution of calcium chloride, 10 per cent, administered intravenously, gave relief even before the injection was completed Later the same day the sensation returned to a lesser degree and was relieved by 10 units of parathyroid extract-Collip (para-thor-mone) given subcutaneously. Beginning a few hours after the

operation, cod-liver oil, viosterol, and calcium chloride were administered daily. The second day after operation the concentration of serum calcium was 7.89 milligrams and

TABLE II

Studies of metabolism of calcium* and phosphorus†

| | Three days pre-operative, average, gram | | Three days post-operative, average, gram | |
	Calcium	Phosphorus	Calcium	Phosphorus
Intake	5.36	4.62	4.485	3.85
Output				
Urine	1.474	2.38	0.03	0.725
Stool	4.10	1.36	2.03	0.740
Total	5.57	3.74	2.06	1.46
Balance	—0.21	+0.88	+2.42	+2.39

* Determinations of inorganic calcium were done according to the method of Kramer and Tisdall except that acidity was adjusted to pH 4.8 to 5.2, the indeterminate range of methyl red; this is according to Shohl.
† Determinations of phosphorus were done according to the method of Fiske and Subbarow.

of phosphorus 2.2 milligrams in each 100 cubic centimetres. It was not until December 12 that the concentration of serum calcium and phosphorus returned to normal limits (Table I). Studies of metabolism a few days after operation revealed a markedly positive calcium balance (Table II). Electrical excitability of the nerves approached normal (Table III). After operation the amount of urine remained practically the same as before operation. Excretion of phenolsulphonephthalein was again 45 per cent.

TABLE III

Contraction caused by electrical stimulation of ulnar nerve

Milliamperes

Date, 1929	Kathodal closing	Anodal closing	Anodal opening	Kathodal opening	Kathodal closing tetanus
November 13	1.8	2.8	4.8	5.2	5.8
December 11	1.2	2.2	3.8	5.6	6.4

The water concentration tests before operation revealed a striking loss of ability to concentrate fluids (Table IV). In none of the tests done before operation did the specific gravity rise above 1.015 and in none of the tests done within four weeks after the operation did the specific gravity reach 1.017. Polydipsia and polyuria were less marked after operation, although this had seemed to occur with some irregularity previously. It was

TABLE IV

Water concentration tests

Date, 1929	Time	Amount, cubic centimetre	Specific gravity
November 1	11 a.m.	95	1.011
	2 p.m.	70	1.014
	5 p.m.	70	1.015
	8 p.m.	75	1.013
	8 a.m.	300	1.011
November 4	11 a.m.	225	1.009
	2 p.m.	200	1.010
	5 p.m.	175	1.010
	8 a.m.	200	1.010

Date, 1929	Time	Amount cubic centimetre	Specific gravity
November 9	11 a.m.	150	1.010
	2 p.m.	100	1.011
	5 p.m.	50	1.010
	8 p.m.	125	1.010
November 16	Operation		
December 6			
	5 p.m.	270	1.012
	8 p.m.	75	1.015
	8 a.m.	450	1.015
December 12	11 a.m.	75	1.016
	2 p.m.	140	1.014
	5 p.m.	175	1.015
	8 p.m.	100	1.015
	8 a.m.	450	1.013

never as marked while the patient was in the hospital as before admission. Appetite was noticeably improved and there were no more vomiting spells. Röntgenograms of the bones taken after operation did not give evidence of increase in density.

Comment.—Albright and Ellsworth, on the basis of their work and of that of Albright, Bauer, Ropes, and Aub, suggested the following hypothesis of the mode of action of parathyroid extract-Collip (para-thor-mone). This seems a most logical hypothesis to account for the changes in the reported cases of hyperparathyroidism. "When parathormone is administered, the equilibria of the body fluids are upset in such a way that an increased phosphorous excretion is a necessary result. We do not know the cause of the increased phosphorous excretion, but as a result of this increased phosphorous excretion the body fluids become depleted in phorphorus. The falling serum phosphorus is evidence of this. As the phosphorus and consequently the phosphate ions in the serum fall, there is a tendency to an unsaturation of the blood with calcium phosphate. This tendency is met by a mobilization of calcium from the bones. Thus a deficit of phosphate ions is being supplied by calcium and phosphate ions. Consequently the serum calcium rises. With a rise in serum calcium, provided the level is not below the threshold for calcium excretion, there is a rise in urinary calcium output."

When the patient in Albright and Ellsworth's case of hypoparathyroidism was under the influence of parathyroid extract-Collip (para-thor-mone) they noted marked polyuria at night. This fact and the presence of polyuria and more or less fixed specific gravity in many of the cases of hyperparathyroidism leads one to suspect disturbed water balance rather than true renal injury. This view is strengthened by the complete, and, at times, rather rapid, return to normal of renal function after removal of a parathyroid tumor.

The occurrence of osteitis fibrosa, multiple giant-cell tumors, and bone cysts, has been explained by Gescheckter and Copeland. They considered that a cyst of bone is an arrested giant-cell tumor; that its formation is a reparative process; and that if multiple cysts and giant-cell tumors are present, some

complicating factor is present which prevents the giant-cell tumors from forming cysts of bone. They presented cases of osteogenesis imperfecta, rickets, syphilis, fragilitas ossium, and osteomalacia in association with multiple cysts of bone and giant-cell tumors.

The general picture of osteitis fibrosa and, in many cases, the occurrence also of multiple cysts of bone and giant-cell tumors, is exactly what one would expect if one accepts Gescheckter. and Copeland's theory as to their formation. The pain- and weakness in the extremities are the direct results of the bony and muscular changes, which are themselves accounted for by the excess of parathyroid secretion in the blood-stream. This also explains the high concentration of serum calcium, the low concentration of serum phosphorus, and the negative calcium balance. There is excellent corroboration of this in the experimental work of Collip and others. Certainly the occurrence of hyperparathyroidism, with its train of changes in bone, would be an ideal complicating factor.

' There is no adequate explanation for the frequent occurrence of gastrointestinal symptoms in the group of cases which has been reported in the literature and which were present in the case reported in this paper. In five cases constipation was a prominent symptom, and in the same cases attacks of abdominal pain accompanied by vomiting had been the outstanding feature of the disease at some time during its course. Frequently these were early manifestations and had entirely disappeared before the patient was admitted to hospital.

The same also might be said of the urinary symptoms. In one case the presence of a renal pelvis full of stones, on which was superimposed a pyogenic infection, would satisfactorily explain the symptoms. In none of the other three cases in which these symptoms were marked was there a suitable or even a plausible explanation unless the hypothesis advanced by Albright and Ellsworth is to be accepted. Accepting the disturbance of water metabolism as the cause of the renal dysfunction, when so little is really known about this subject itself, is to open a question over which there has been considerable controversy. However, we can think of no other explanation which would so satisfactorily explain the rapid return to normal of some of the urinary symptoms after the parathyroid tumor was removed.

Our patient is the youngest who has been proved to exemplify the clinical syndrome which is the subject of this paper. The symptoms of this patient were of shorter duration and the chief complaints related to the gastrointestinal and genito-urinary systems rather than to the osseous system as in all the other cases. Although the röntgenograms of bones did reveal evidence of diffuse decalcification of all the bones, they certainly did not disclose anything that was characteristic for osteitis fibrosa. We have no means of knowing to what extent the process in the bones would have gone had the parathyroid tumor not been removed. Probably the patient would have had symptoms referable to the osseous system had the negative calcium balance persisted for a sufficiently long time. Following operation the gastro-intes-

tinal symptoms promptly cleared up as has been the case in the other cases reported. The return of renal function to normal has not been so rapid as in some of the other cases. Six days after operation the excretion of phenolsulphonephthalein was the same as before. The water concentration tests revealed slight improvement in the ability of the kidneys to concentrate fluids. Electrical reaction was not markedly lacking before operation, but it was practically normal a few days after operation. Röntgenograms of bones four weeks after operation did not reveal increase in density.

SUMMARY

A case of hyperparathyroidism in a young girl is described in which symptoms were due to excessive parathyroid secretion caused by a parathyroid adenoma. The symptoms and data include progressive weakness and loss of muscular tonus, attacks of abdominal pain and vomiting, anæmia, polydipsia and polyuria, hypercalcemia and hypophosphatemia, and diffuse decalcification of the skeleton. Data concerning six other proved cases and three not proved by operation were gathered from the literature.

The surgical removal of the parathyroid tumor in the case reported was followed by marked relief from all symptoms.

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THE TREATMENT OF ACUTE EMPYEMA THORACIS

WITH A REPORT OF 153 CONSECUTIVE CASES

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THIS paper does not attempt a comprehensive survey of the methods of treating empyema. We wish only to note briefly the present physiological and pathological principles underlying its treatment, to present the method of treatment used at the New Haven Hospital and to report the results.

This disease has been recognized since the days of Hippocrates. The development of therapeusis has been slow, at times even stationary, until the latter part of our modern era of surgery. During the World War the work of the Empyema Commission with Graham, Bell and others did much to formulate the present concepts of physiology and pathology needed in the sane treatment of this disease. A tremendous operative mortality has been reduced to almost nothing while morbidity in the form of chronic empyema is rapidly decreasing.

It is now generally recognized that a diagnosis of empyema does not necessarily constitute an indication for immediate operation. It has been learned that the sudden change of a normal negative intrathoracic pressure to a pathological atmospheric pressure may result in respiratory failure; from collapse of the lung, mediastinal shift, and reduction in vital capacity where vital capacity is already lowered by disease. Attention has been drawn to the cardiac embarrassment from mediastinal shift and kinking of the venacava and other vessels. The postponement of an open thoracotomy until the pulmonary lesion subsides, the vital capacity becomes more normal, and adhesions between the parietal and visceral pleura stabilize the intrathoracic organs, means that no deaths will follow the acute operative pneumothorax from collapse of the undiseased lung.

On the other hand adequate drainage just as soon as it can be obtained safely is to be desired because the pleura rapidly thickens, adhesions quickly form and the cavity becomes more rigid, thus militating against re-expansion of the lung and obliteration of the empyema cavity. There is then the danger of pulmonary collapse from an operative procedure done too early and the danger of chronicity from an operative procedure done too late.

It is also generally recognized that this intrathoracic process varies with the type of infection. In a streptococcus pneumonia, the pleura is infected early and a well advanced pleurisy may be associated with a still prominent intrapulmonary infection. In a pneumococcus pneumonia the pleurisy is often a late manifestation and the pneumonic process may have run its course before the pleurisy becomes a serious affair.

Aspiration, intercostal drainage, rib resection, double intercostal drainage with irrigation, radical thoracotomy with closure and intercostal drainage below, intercostal drainage with tidal irrigation, or various combinations and modifications of these methods are in vogue in various parts of the country. An evaluation of each type of treatment is not the purpose of this paper. The value of intercostal drainage and the value of open thoracotomy with their dangers and their faults is generally known and understood. Whatever method is used, it should yield a low mortality, a complete healing and restoration of pulmonary function, the shortest possible convalescence and at the same time be as simple and practicable as possible.

The mortality with various types of modern treatment properly carried out is much the same. A fatality should never result from the empyema itself. Death does occur in a certain number of instances due to the intra-

MORTALITY

TABLE I

Relation to Organism

Organism	No. cases	Deaths	Per cent mortality
Pneumococcus Type I....................	36	2	5.5
Pneumococcus Type II...................	5	2	40.
Pneumococcus Type III..................	7	0	0
Pneumococcus Type IV..................	15	2	13.3
Pneumococcus Type undetermined	15	2	13.3
Streptococcus hemolyticus...............	25	3	12.
Non Hem. streptococcus.................	12	0	0
Staphylococcus aureus..................	9	2	22.2
Staphylococcus albus...................	0	0	0
Unknown or mixed.....................	29	4	13.7
Total...........................	153	17	11.1

pulmonary process, septicemia, multiple infections, pericarditis or other complications. Incomplete healing, however, varies with the different types of treatment, the care with which the treatment is carried out, etc., and reports of chronicity range from 0 to 50 per cent. Chronicity in non-tuberculous empyema is generally understood to result from one or more of the following causes: Improper drainage, an operative procedure done too early, one done too late, foreign bodies in the pleural cavity or osteomyelitis of the ribs. The most important of these is improper drainage. All of these causes should be preventable.

The period of convalescence likewise varies with the method used, but also depends upon the type of the infecting organism, the severity of the infection and the time in the disease when the treatment is instituted. That the method should be as simple as possible goes without saying, but important features in the treatment should not be omitted for the sake of simplicity.

The treatment for acute suppurative pleurisy used at the New Haven Hospital was worked out by Dr. Joseph Marshall Flint, formerly professor

of surgery at Yale, and is based on the physiological principles discussed. The better features of the closed method of treatment have been combined with those of the open method. Plugging of the drainage tube, the great criticism of the closed method, has been corrected by rib resection and the use of a large tube, while the value of negative intrathoracic pressure has been retained by a special type of tube and constant suction. We believe that suction is a very important feature in our treatment. A quantitatively controlled and continuous negative pressure aids re-expansion of the lung and obliteration of the cavity, but most important of all it keeps the pleural cavity empty of secretions. The so-called "operative shock" of opening the thorax has been largely reduced by careful local anæsthesia and avoidance of wide-open exploration. Rib resection has been delayed until the intrathoracic pathology has undergone enough change to make it safe, but repeated aspirations have checked the mechanical dangers and alleviated the absorptive features of the pleurisy. It is believed that this delay has not increased our

TABLE II
Relation to Age

Age group	No. cases	Deaths	Per cent mortality
Under two years	23	5	21.7
2–12	69	4	5.7
12–40	47	6	12.7
40–	14	2	14.2
Total	153	17	11.1

6 deaths last 83—7.2 per cent

mortality, and that it has not resulted in chronicity is shown in our results.

The outline of our treatment is as follows: A diagnosis is made as early as possible and is followed by a microscopic and cultural study of the infecting organism. Treatment by repeated aspirations is carried out, using precautions to prevent infections of the thoracic wall, until the pulmonary process is minimal, the thoracic organs more or less fixed and the specific gravity of the pleuritic fluid has increased to such an extent that it cannot be readily drawn through the aspirating needle. When the pleuritic fluid is frank pus, rib resection is usually safe, but this alone should not be the criterion for selecting the time of operation. As previously stated the pneumonic process must be evaluated and the character of the infecting organism must be known. A pneumococcus pleurisy may be operated upon long before the pleuritic fluid becomes so thick that it cannot be aspirated and the operation should be done just as soon as it is safe. Rib resection using novocaine anæsthesia is then carried out. The technic we use is as follows: The location of the incision, if possible, is at the midaxillary line at about the level of the eighth or ninth rib so that the tube externally is well above the bed and the intrathoracic portion of the tube is high enough to be away from a rising diaphragm. This location obviously must vary in many cases. All

rib resections are preceded by needling on the operating table and the pleura is opened only when the pleura has yielded fluid. A rib is then resected for a distance of four to eight centimetres, being careful that no rib is left uncovered by periosteum. In the two cases of osteomyelitis of the rib in this series this precaution was not carried out and the bared rib ends were covered with bone wax. If the rib ends are rongeured well into the periosteal covering, the danger of osteomyelitis is small. The pleura is then opened using a small incision in the base of the rib bed and air is allowed to flow into the thoracic cavity slowly so that any readjustment here will not be sudden. If no respiratory difficulty is encountered, the opening is enlarged and the fluid and fibrin clots are evacuated by aspiration. Fibrin clots may be floated up to the pleural opening with saline and removed, if the cavity is well walled off.
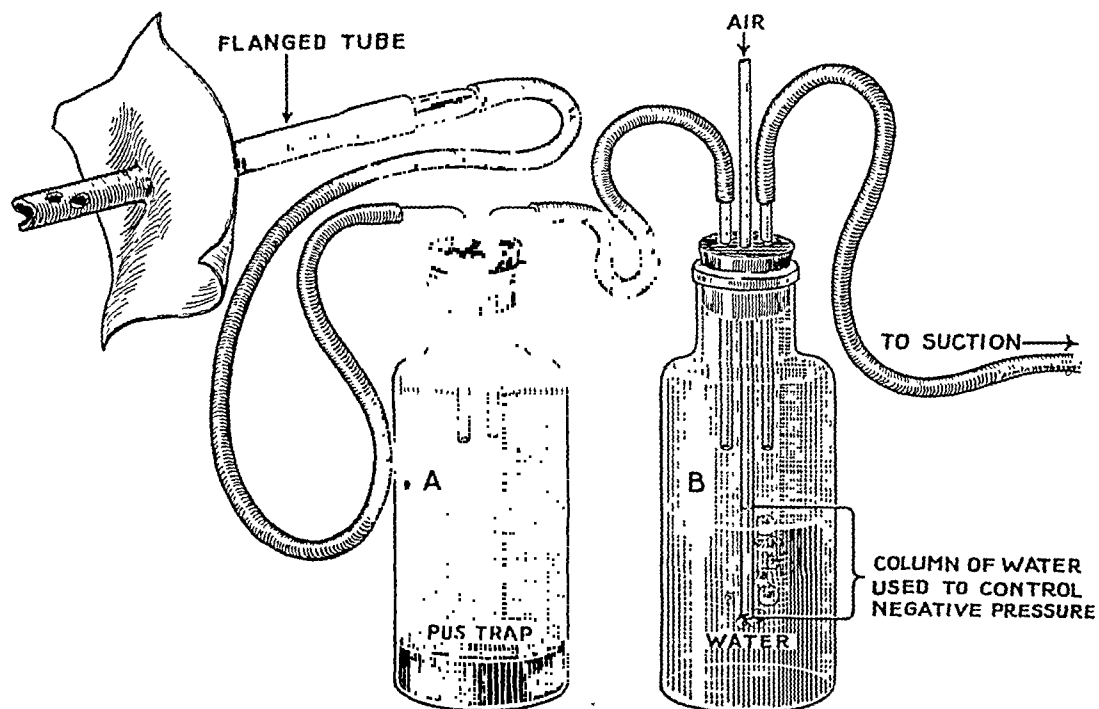

DIAGRAM - I - CONSTANT NEGATIVE PRESSURE APPARATUS WITH PUS TRAP.

Exploration with the finger is often easily carried out, but care is used that parietovisceral adhesions are not broken down. This procedure is not intended to be a wide open exploratory thoracotomy. The special flanged empyema tube is then placed well into the cavity with the intrathoracic part fenestrated. The soft tissues are closed snugly around the tube, the skin is covered with zinc oxide or some similar material and the flanged rubber dam portion of the tube is held in place by firm adhesive strapping to the chest wall. This is held in turn by a many tailed binder so that a firm air-tight dressing is established. The end of the tube is clamped at the end of forced inspiration and the patient is returned to the ward where the tube is connected to the constant negative pressure apparatus. This is simply a tube leading to a bottle serving as a pus trap on the floor. This connects with a similar bottle partly filled with water where negative pressure is maintained by suction and controlled by the simple device shown in the diagram. The main-

tenance of a definite, uniform, continuous suction is a very important feature in the treatment, and this is taken care of by a vacuum pump installed in the basement. This pump with its vacuum chamber is connected by piping to the wards, porches and operating rooms and affords a continuous and unfailing source of negative pressure. The various forms of suction obtained from water pumps, inverted water bottles, etc., we have found unreliable and unsatisfactory.

TABLE III
Comparative Mortality Charts

Operator and hospital	Time	Type operation	No. cases	No. deaths	Per cent mortality
Binney, H. Boston City Hosp.	1928	Closed Few late ops. Open method	126	14	11
Heyer, Y. Johns Hopkins Hosp.	1923	Mixed	425 J. Hop. 30 Cinn. Gen.	62	15.4
Ladd & Cutler Childrens Hosp.	1924	Closed Open Under 2 yrs.	42 226 48		28 15.9 35.5
Hart, Deryl Baltimore	1929	Closed Tidal irrigation	50		10
Graham, E. Barnes Hospital, St. Louis		Closed?	86		11
Brown, Henry P. Childrens Hosp., Philadelphia	1923	Rib resection Intercostal	171 54		21 40
Wilensky, A. O. Mt. Sinai	1903	13 Open and various ops.	225	59	23
Lloyd, Samuel N. Y. Post-Grad.	1907	Open	225	47	20
New Haven Hosp.	1929	Closed suction	153	17	11.1

The post-operative treatment is decidedly easier than that necessary in the usual open thoracotomy. The nurse measures and charts the daily drainage, and checks the apparatus to be sure it is working. This is very simple. The water in bottle B (see diagram) ceases to bubble when the system is plugged or stopped in any way, and with this and the drainage chart a simple but sure check-up of progress is obtained. At the end of the first week the dressing is usually done, the stitches taken out, the tube removed, cleaned and sterilized, shortened and reinserted. This shortening is continued until the pleural cavity is completely obliterated when the apparatus is discarded. Care is taken that the sinus tract in the thoracic wall is kept open until the cavity is completely obliterated. Another important feature in the treatment is that at necessary intervals during the convalescence

the outline of the cavity is mapped out by X-ray after filling with a solution of sodium iodide or some other opaque media, and in this way pocketing or delay in lung expansion is ascertained. Blow bottles are used to help re-expand the lung, and measures directed toward building up the patient's general condition are carried out.

We have not depended upon irrigation with Dakin or other solutions to sterilize the cavity. There have been bronchial fistulæ in this series. Some have delayed convalescence, but they have uniformly closed spontaneously. This type of treatment does not confine the patient to his bed but can be carried out just as effectively with the patient in a wheel chair in the ward or on the porch. An attempt has been made to keep all patients in the hospital until the pleural cavity has been completely obliterated and the sinus tract healed.

RESULTS

This series includes all the cases of post-pneumonic empyemas admitted to the New Haven Hospital* and treated by the staff from 1919 to 1929 with the exception of a few cases admitted late in the disease where the classical open thoracotomy was employed, and two cases treated by the method described, discharged with obliterated cavities but untraceable. There were 153 cases treated by the method described. The first 70 of this group were followed and examined by Beverly Douglas. The last 83 have been followed and examined personally by some member of the Staff with the exception of 7. These have been examined by their family physicians. We do not believe that any case even healed at discharge followed for a short time can be called a cure. We have had many cases treated elsewhere discharged with superficially healed wounds and pronounced cures who have come to this hospital many years later with a recurrent or persistent empyema. One case in our series was followed for two and one-half years. No general or pulmonary symptoms were present and no local signs of disease were noted except those interpreted as thickened pleura. However, three years after his discharge he returned with an empyema necessitatis and a chronic empyema. This case was not checked accurately with follow-up X-rays of his injected cavity, and his sinus tract was allowed to heal before his cavity was obliterated. We believe a superficially healed wound as a measure of cure is a very poor one, and that complete obliteration of the pleural cavity is necessary to prevent recurrence or continuation of the disease.

In the 153 cases there were 17 deaths, a mortality of eleven and one-tenth per cent. In the first 70 cases (followed by Douglas) there were 11 deaths with a mortality of fifteen and seven-tenths per cent. In the last 83 there were 6 deaths with a mortality of seven and two-tenths per cent. Of 36 cases of pneumococcus I empyema, there were 2 deaths, a mortality of five and five-tenths per cent, while in 25 cases in which the streptococcus hemo-

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* Dr. Maxwell Lear has reported some of these cases in the Proc. Conn. State Med. Society, May 28, 1924; and Dr. Beverly Douglas has used a few of these cases in a report soon to be published.

lyticus was the infecting agent, there were 3 deaths, a mortality of twelve per cent. There were no deaths at or immediately following operation.

Of these 17 cases, there were 2 where death may have been due to or hastened by faulty application of our method. One, a female child fifteen months old, developed scarlet fever on her fifth post-operative day, was transferred to the Isolation Pavilion and the suction tube was removed. Marked respiratory · difficulty with faulty oxygenation and cyanosis, rapid pulse, etc., was followed by death in spite of the rather late administration

TABLE IV
Comparative Chronicity Table

Clinic—operator	Time	Type operation	No. cases	No. chronics	Per cent chronicity
Binney, H. Boston City Hosp., Boston	1928	Closed method Few open method	126	6	4.7
Heuer Johns Hopkins Hosp.	1923	Mixed	425 J. Hop. 30 Cinn. Gen.		20 Some on admission
Ladd & Cutler Childrens Hosp., Boston	1924	Closed Open	42 226		50 4
Hart, Deryl Baltimore	1929	Closed Tidal irrigation	50	0 2 osteo-myelitis	0 4
Brown, Henry P. Childrens Hosp., Philadelphia		Rib resection Intercostal	171 54		47 37
Wilensky, A. O. Mt. Sinai Hosp.	1903	13 Open and various ops.	225		23
Lloyd, Samuel N. Y. Post-Grad. Hosp.	1907	Open	225		Many
New Haven Hosp.	1929	Closed suction	153	1 2 osteo-myelitis	0.6 1.2

of oxygen and an attempt to correct the intrathoracic situation. The other was a seriously ill infant who developed an abscess of the thoracic wall following a diagnostic thoracentesis. The pleura was punctured and an emergency thoracotomy was done far too early in the course of the disease. Pulmonary collapse ensued, which was partly controlled by suction. The wound broke down five days after the thoracotomy and in spite of resuture and reapplication of suction the patient died. In the remaining 15 cases, there were 7 autopsies; pericarditis, mediastinitis and pneumonia were shown to be present in 2 of these 7 cases. Meningitis was present in one, endocarditis with septicemia and pneumonia in 2, bilateral pneumonia and pleurisy

was present in 1 and bilateral pneumonia with multiple abscesses was present in the last. In one of the 8 cases where autopsies were not obtained, the cause of death was a severe pulmonary hæmorrhage from a tuberculous pulmonary lesion. The other 7 presented the clinical picture of an overwhelming infection.

When the deaths are classified according to age, the highest mortality is found in the group under two years, 21.7 per cent, while the lowest mortality is present in those patients between two and twelve years, 5.7 per cent.

In summarizing our mortality, it seems fair to state that in two cases of the 153, death was due to the empyema. But we feel that these deaths were preventable and due to errors on our part. In the remaining 15 fatalities, the cause of death could not be attributed to the empyema per se.

In our statistics relative to the duration of treatment we could not use all of the 153 cases. The choice of the optimum time for operative interference did not rest with us in some of these, because they were admitted to the hospital late in the disease. In others, a definite history of the time of onset could not be obtained and in a few cases, the exact time of complete closure of the sinus tract could not be accurately ascertained because these patients left the hospital before they were entirely healed. However, there are 110 cases with a definite history suitable for statistical study. We have not attempted an accurate estimation of the duration of pleurisy before operative interference for the reason that the exact time of onset is often difficult to state. The average number of days from the onset of the pneumonia until operative interference has been used. With a pneumococcus I empyema, this was 18.7 days, while the average with a streptococcus empyema was 29.5 days. This collaborates the usual clinical experience that a streptococcus pleurisy must be operated late. This figure indeed may be misleading because the onset of the pleurisy is early in a streptococcus infection so that more days of actual pleurisy are present than is apparent from this comparative figure.

The average number of days required before closure of the pleura was 5 days longer with a streptococcus infection. The total average number of days of all cases before operative interference was 24.1 days or just over 3 weeks. The average time for the pleural cavity to become obliterated and closed was 40 days, just under 6 weeks while complete healing required 7 weeks and 2 days; a total period averaging 75 days—10 weeks and 5 days.

Regarding the third feature of our consideration, chronicity, two cases have had osteomyelitis of the ribs and have required secondary operations for the removal of infected bone. One case operated upon very early after the onset of a pneumococcus empyema had a bronchial fistula, a partial collapse of the lung and required 118 days before his pleural cavity was obliterated and his sinus tract healed. One case previously mentioned discharged before complete obliteration of cavity returned three years later with a chronic empyema. We have regarded any instance where a secondary operation was necessary as a chronic empyema. We have three in this group, two of these with

obliterated empyema cavities but with osteomyelitis of the ribs. The pleural cavity has been obliterated without operative interference and remained so in all cases except the one mentioned. It is interesting to note that in this series of cases there were two with a bilateral empyema, both received bilateral drainage and were treated with the usual suction tube drainage, and both cases healed rapidly and without complications. There was also one case of acute suppurative pericarditis occurring in a patient already undergoing treatment for his empyema where the pericardial cavity was drained and both cavities healed well without complications or sequelæ.

SUMMARY

A brief resume of the present physiological and pathological concepts underlying the treatment of acute suppurative pleurisy is followed by a description of the method of treatment used in, the New Haven Hospital.

TABLE V

Duration of Treatment—Only Cases Admitted to Hospital Early in Disease

Organism	No. cases	Average no. days from onset pneumonia to oper.	Average no. days from onset pneumonia until pleura closed	Average no days from onset pneumonia for complete healing
Pneumococcus Type I. .	30	18.7	39.3	49 3
Pneumococcus, all other types	24	24 1	42.7	54 5
Hemolytic streptococcus	24	29 5	44	56.7
Non-hemolytic streptococcus	5	28 6	30 7	42 5
Staphylococcus {Aureus} {Albus }	5	17.8	47	58.7
Unknown and Mixed .	22	24 2	38 8	47.8
Average all types .	110	24 1	40.6	51 3

Essentially this is thoracentesis, delayed partial costectomy and constant suction tube drainage.

Results obtained in 153 cases of post-pneumonia empyema treated by this method are charted and discussed regarding mortality, length of convalescence and chronicity, with the various types of infecting organisms, and as a whole. Of the 17 deaths, 2 were due to the empyema, but both of these should have been prevented. The other 15 deaths were due to overwhelming infections and complications. The average length of treatment in this series was three weeks from the time of the onset of the pneumonia until operative interference, just under six weeks from the onset for obliteration of the empyema cavity and just over seven weeks for complete healing. There were two cases of osteomyelitis in this series. There was one instance in which the pleural cavity was not obliterated due to faulty post-operative care.

CONCLUSIONS

One hundred and fifty-three consecutive cases of post pneumonic empyema are reported, treated by delayed costectomy and constant suction tube drain-

age, with uniform and complete obliteration of the empyema cavity except in one case. From study of this series we believe it fair to assume that:

1. Death should never result from empyema thoracis per se.

2. Chronic empyema should not occur in properly treated cases of acute suppurative pleurisy.

3. The basis of the determination of a cure should be the disappearance of all signs of sepsis, a complete obliteration of the empyema cavity as well as a healed superficial wound, and a long time follow-up.

I wish to express my indebtedness to Dr. Samuel C. Harvey for his valuable criticisms and suggestions.

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A BACTERIOLOGICAL AND CLINICAL STUDY OF GASTRIC ULCER*

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THIS investigative work here reported has been made possible by the collaboration of the Department of Surgical Research, the Second Surgical Division (Bellevue) and the Department of Public Health and Preventive Medicine of Cornell University Medical College and respectively directed by Dr. Joshua E. Sweet, Dr. Harold Santee, Dr. John C. Torrey and Dr. Morton Kahn.

The study involves a bacteriological and clinical investigation of gastric, duodenal and gastro-jejunal ulcer, the results of which support the theory that their etiology is due to a specific infection.

Etiological theories other than infection may be grouped under four headings; namely:

1. *Vascular.*—Resulting from a deficient blood supply to the gastric mucosa.
2. *Toxic.*—Resulting from the action of toxic agents.
3. *Neurologic.*—Resulting from trophic and glandular disturbances.
4. *Chemical.*—Produced by the action of the digestive juices.

The vascular theory is supported by the fact that intravenous injections of material causing emboli, ligation of more than one-third of the blood supply to the stomach, the injection of drugs causing spastic contraction and local ischæmia, with resulting local areas of anæmia, and ligation of the portal vein, or an Eck fistula in dogs, ulcers of the stomach will be produced inconstantly. Prolonged starvation will do the same.

Because of the fact that lesions of the stomach resembling ulcer result when toxic drugs and chemicals are injected locally or generally, and that similar lesions are produced when biologic toxins, foreign protein, dead bacteria, filtrates of living bacteria, gastro-toxic serums, hepatotoxin, enterotoxin and extracts of burned tissue, the toxic theory originated and survives.

When the spinal cord, anterior corpora quadrigemina, median splanechnic nerves or vagi are sectioned, ulcer results inconstantly, and likewise when the celiac plexus is extirpated. Lesions of the suprarenal glands occur following nerve section. Removal of the adrenals without nerve section is sufficient to cause ulcers to form. These factors support the trophic and glandular theory.

Leriche has lately asked the question, "How could ulcers, so large and adherent that their resection was technically impossible, heal so rapidly fol-

lowing gastroenterostomy or simple excision if they were trophic in origin? How could resected stomachs heal so well in patients who have had an ulcer for a great number of years, if there was any trophic disturbance of the stomach?"

Gandier[5] has lately cited a case in whom a deinervation of the stomach was done because of ulcer symptoms but no ulcer was demonstrable at the time of operation. Less than a year later the patient was reöperated upon for a perforated gastric ulcer which developed after deinervation.

That these three methods of experimental approach will inconstantly produce ulcers in the stomach of the animal is true. That they have the characteristic feature of the human ulcer, namely, chronicity, is not true.

The only experimental method which has consistently produced ulcers in the pyloric region of the stomach of the dog comparable to those found
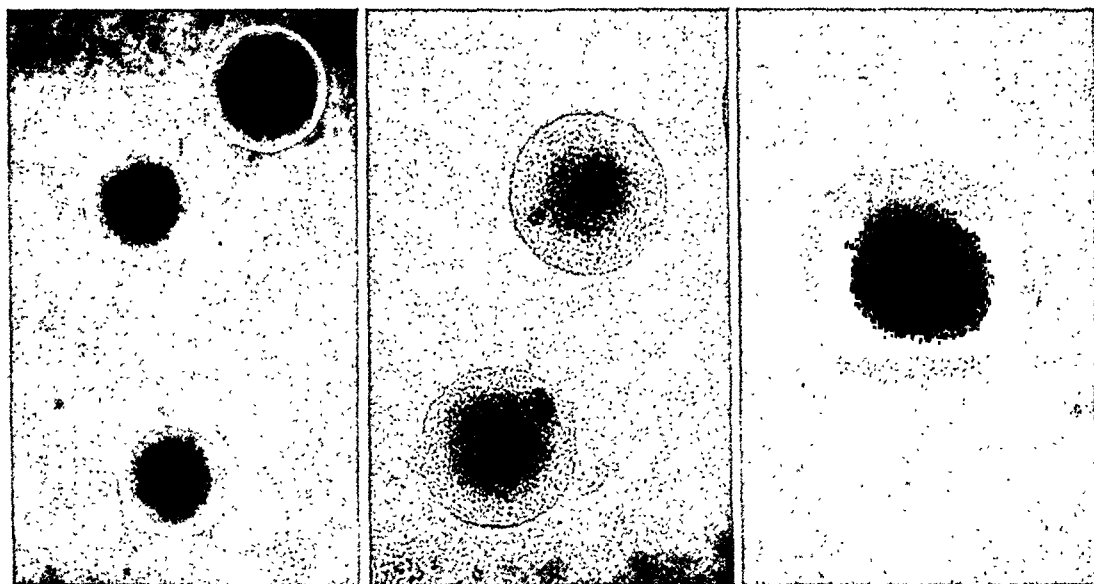
PLATE I

FIG. 1.—All S colonies culture 63.   FIG. 2.—All S colonies culture 68.   FIG. 3.—First appearance of O intermediate change. Culture 64.

in man has been that of surgical duodenal drainage which mechanically brings about a disturbance of the acid and alkali (or bile), at the pylorus. The ejected acid stream from the stomach strikes a loop of anastomosed jejunum unprotected by alkaline duodenal contents. Chronic ulcers result which can later be healed by reintroduction of alkali (bile), by gastro-jejunostomy and pyloric exclusion protecting the ulcer from acid chyme. This work originally done by Mann and Williamson[1] and corroborated by Morton,[2] McCann, and lately Weiss[4] is beyond experimental error. There can be no question, therefore, that normal duodenal contents have some protective action preventing the formation of an ulcer. This is strengthened by the fact that tying off the common duct causes ulcers to form in the duodenum inconstantly, and that ulcers have formed following chronic biliary fistulæ in humans.

Mechanical and anatomical factors may play a rôle. The duodenum is

the region of greatest fixation and the poorest and most tortuous blood supply. The normal protecting rugæ of the mucosa are sparse or absent at the pylorus and the mucous membrane of the duodenum is extremely friable. The muscular activity of the antrum and valve itself, which is easily thrown into severe contraction and spasm from irritation as one observes experimentally, plays a rôle.

As will be indicated later, the pertinent anatomical relationship may be with the biliary passages rather than with the above-stated factor, and equally important may be the functional mechanism which makes possible regurgitation into the first portion of the duodenum and stomach of alkaline duodenal contents rather than the passage out from the stomach of acid contents.

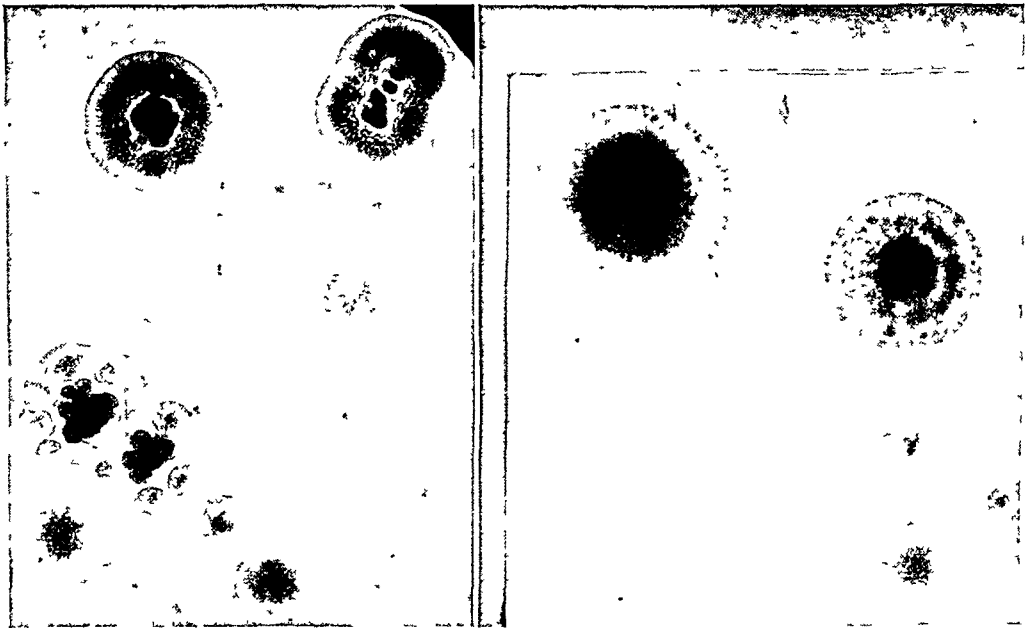The ulcer patient is invariably of the asthenic type with a narrow costal

PLATE II

FIG 4—S and O colonies. Culture 60A   FIG 5—S and O colonies   O colonies showing ring
                                                  of daughter colonies   Culture 59A

angle, and similar sharp duodenal angle which anatomically should hinder bile regurgitation into the first portion of the duodenum.

The theory that gastric ulcer has an infectious origin is as old as the first anatomical description of ulcer. Investigators in every decade for the past 100 years have brought forward evidence to prove its infectious origin. The literature has been completely reviewed in a previous article.[3]

The following investigative results are offered to again support this theory.

1. Pathological investigation of immediately prepared resected specimens reveals typical inflammation, showing zones of exudation, fibrinoid necrosis, granulation and cicatrization. The exudation may be purulent, fibrino-purulent or catarrhal. Granulation tissue is variable in extent and is not different from granulation tissue elsewhere. When fresh specimens were fixed immediately and stained by the method of Levaditi, a rim of strepto-bacilli was always present covering the necrotic surface of the mucous mem-

brane. Single cocci, diplococci, strepto-bacilli and rods were constantly present in the exudate which forms the surface of the ulcer. Phagocytic white cells showing large stained granules were numerous in the sanguino-exudate. The organisms were practically never found below the submucosal layer. If the base of the ulcer was a cicatrized muscle layer, the mucosa being entirely destroyed, no organisms were found. The glands of the mucosa adjacent to the exudative necrotic crater would invariably show organisms and beginning destruction. The mucosa not adjacent to the crater appeared normal and the rim of organisms on the surface stopped. Although definite thrombosis of vessels is noted microscopically, it could better be explained as an antecedent rather than a precedent factor. A few slides have shown organisms in the thrombosed lumen.

TABLE I

Sources of single colony strains from stomach

Patient	Hospital – Surgeon	Ulcer	Single Colony Strains		
1. Male	Second Surgical Bellevue Santee	Large gastric lesser curvature	1. A' 3. A. 2. A 4. A		
2. Male	Second Surgical Bellevue Santee	Small gastric lesser curvature	19. AA' 21. AA' 20. A 22. A		
3. Male	Second Surgical Bellevue Santee	Small gastric lesser curvature	23. A 23b. A 23d. A 23a. A 23c. A 23e. A		
4. Male	Second Surgical Bellevue Santee	Carcinoma ulcer mid-stomach	45. A 45b. A 45d. A 45a. A 45c. A 45e. A 45fA		
5. Male	Mount Sinai 300520 Berg	Duodenal	46. A 46a. A 46b. A.		
6. Male	Mount Sinai Private Patient—Berg	Large gastric lesser curvature	47a. A 47b. A. Eight strains		
7. Male	Mount Sinai 300854 Berg	Large gastric lesser curvature	53. A 53b. A. 53d. A 53a. A 53c. A.		
8. Male	Second Surgical Bellevue Dudley	Gastrojejunal	55. A 55b. A 55d. A 55a. A 55c. A		
9. Male	Second Surgical Bellevue Dudley	Gastrojejunal	56. A. 56a. A.		
10. Male	Second Surgical Bellevue Dudley	Large gastric lesser curvature	58. A'.		
11. Female	Second Surgical Bellevue Santee	Two prepyloric ulcers, carcinoma	59. A 59. A'		
12. Female	Second Surgical Bellevue Santee	Prepyloric ulcer, carcinoma, Metastases	60. A 60. A'		
13. Male	Second Surgical Bellevue Santee	Large gastric pars media	61. A'		
14. Male	Second Surgical Bellevue Santee	Large gastric perforated, pars media	62. A'		
15. Male	Second Surgical Bellevue Santee	Gastric ulcer lesser curvature	63. A'		
16. Male	Second Surgical Bellevue Santee	Perforated duodenal ulcer	64. A'		

TABLE I—*Continued*

Patient	Hospital–Surgeon	Ulcer	Single Colony Strains
17. Male	Second Surgical Bellevue Santee	Prepyloric ulcer polypoid carcinoma	66. A' 66. B.
18. Male	Second Surgical Bellevue Santee	Duodenal healed gland lesser curvature	67. A'
19. Male	Second Surgical Bellevue Santee	Large prepyloric ulcer	68. A'

A—Viridans—slight hemolysis   AA'—degree between A and A'
A'—Viridans—marked hemolysis   B'—complete hemolysis

This classification is based upon the degree of hemolysin produced by the organism. It seems, however (see text), that this hemolysin production is variable. It appears to be lost when the organism shifts from the S to the R type, but this point must be investigated in detail before it is accepted in its entirety. If such proves to be the case, however, it would seem that a reconsideration of classification of the streptococci on the basis of hemolytic activities would be necessary.

1928–1929

TABLE II

Agglutination and absorption table
(a) Agglutination with serum 2

Antigens	1–100	1–200	400	800	1600	3200	6400	12800	Control
Gastric 2	#	#	#	#	#	+⏐	+	±	−
Gastric 20	#	#	#	#	#	+	±	⏐	−
Gastric 23	#	#	#	#	#	+⏐	+	±	−
Gastric 45	#	#	#	#	#	+	±	⏐	−
Gastric 47	#	#	#	#	#	+⏐	±	±	−
Gastric 53	#	#	#	#	#	+⏐	+		−
Gastric 55	#	#	#	#	#	+	±	⏐	−
Gastric 56	#	#	#	#	#	+	±	⏐	−
Gastric 9	#	#	#	#	#	+	±	−	−
Throat 29	#	#	#	#	#	+⏐	+	⏐	−
Throat 38	#	#	#	#	#	+	±	⏐	−
Throat 39	#	#	#	#	#	+⏐	±	⏐	−
Throat 44 A	#	#	#	#	#	+	±	⏐	−
Gastric 58	#	#	#	#	#	+⏐	±	⏐	−

(b) Absorption of serum 2

Antigens	1–100	200	400	800	1600	3200	Control
Gastric 2	−	−	−	−	−	−	−
Gastric 20	−	−	−	−	−	−	−
Gastric 23	−	−	−	−	−	−	−
Gastric 45	−	−	−	−	−	−	−
Gastric 46	−	−	−	−	−	−	−
Gastric 47	−	−	−	−	−	−	−
Gastric 53	−	−	−	−	−	−	−
Gastric 55	−	−	−	−	−	−	−
Gastric 56	−	−.	−	−	−	−	−
Gastric 9	−	−	−	−	−	−	−
Throat 29	−	−	−	−	−	−	−
Throat 38	#	+	⏐	−	−	−	−
Throat 39	#	−	−	−	−	−	−
Throat 44 A	#	#	+	±	−	−	−

TABLE II—*Continued*

Lip ulcer strain from penetration of tooth—Serum 40

Antigens	1-100	1-200	400	800	1600	3200	6400	12800	Control
Lip ulcer 40	#	#	#	#	+|	+	±			—
Teeth 15	#	#	+|	+			—	—	—	—
Teeth 17	#	#	+|	±	—	—	—	—	—
Lip ulcer 31	#	#	#	+			—	—	—	—
Hand ulcer 7	#	#	#	+|	±			—	—	—
Hand ulcer 11	#	#	#	+	±	—	—	—	—
Hand ulcer 30	#	#	#	±			—	—	—	—
Gastric 2	#	#	+|	+	±	—	—	—	—

Note.—For all methods of technic, see previous article.[3]
\# indicates complete agglutination—fluid clear
+| indicates nearly complete agglutination—slightly cloudy and fluid clumps smaller
+ indicates 50 per cent complete
± indicates slightly less than 50 per cent
| indicates trace of agglutination

1929–1930

TABLE III

Agglutination table—Agglutination with Serum 66

Antigens	1-100	1-200	400	800	1600	3200	6400	12800	Control
Gastric 66	#	#	#	#	#	+|	±	—	—
Gastric 58	#	#	+|	+	+			—	—	—
Gastric 59A	#	#	#	#	+|	+|			—	—
Gastric 59A'	+|	+|	+|	+|	+	+			—	—
Gastric 60A	#	#	#	#	+|	±			—	—
Gastric 60A'	#	#	#	#	#	+	±	—	—
Gastric 61	#	#	#	#	+|	+|	±	—	—
Gastric 62	#	#	#	+|	+|	+	±	±	—
Gastric 63	#	#	#	#	#	+|	±	—	—
Gastric 64	#	#	#	#	#·	+			—	—
Gastric 67	#	#	#	#	#	+|	—	—	—

Absorption table—Absorption of Serum 66

Antigens	1-100	1-200	400	800	1600	3200	Control
Gastric 66	—	—	—	—	—	—	—
Gastric 58	—	—	—	—	—	—	—
Gastric 59A	—	—	—	—	—	—	—
Gastric 59A'	—	—	—	—	—	—	—
Gastric 60A	—	—	—	—	—	—	—
Gastric 60A'	±	—	—	—	—	—	—
Gastric 61	—	—	—	—	—	—	—
Gastric 62	—	—	—	—	—	—	—
Gastric 63	—	—	—	—	—	—	—
Gastric 64	—	—	—	—	—	—	—
Gastric 67	±	—	—	—	—	—	—
Gastric 68	+	±	—	—	—	—	—

Note.—Strain 68 proved identical by absorption. Last culture obtained and not yet homogenized for cross agglutination.

Series 1929–1930 identity with Series 1928–1929 proved by Strain 58.

2. A green-producing streptococcus which can be classified as an alpha or alpha prime type, depending upon its stage, which will be referred to later, has been cultivated from nineteen resected gastric, duodenal and gastrojejunal ulcers and proved to be an agglutinogenic and antigenic homolog by differential cultural tests and by agglutination, cross agglutination and agglutinin absorption.

Four partially healed duodenal ulcers and one gastric ulcer in patients in whom a gastroenterostomy was present gave sterile cultures. Other organisms grown inconstantly were the B. welchii, B. coli, a gamma enterococcus, Opler-Boas bacillus, a Gram-negative diplococcus resembling one of the throat organisms described by Elser and Huntoon and a Gram-negative chained bacillus. The last four were only present in five of the largest gastric ulcers which were both macroscopically and microscopically cancer.

Ten of the cultures gave a pure growth of the alpha streptococcus.

Normal stomach wall gave repeatedly negative cultures except for a gamma enterococcus and B. coli.

By the same methods the gastric alpha streptococcus strain has been shown to have agglutinogenic and antigenic identity with four alpha strains cultured from the lesions of four cases of an acute specific disease characterized by small ulcers of the lip, tongue, buccal membranes and tonsils. It has been shown to have a relationship but not to be identical with alpha prime strains producing ulcers of the skin but not to be related to alpha strains from teeth and tonsillar foci of patients suffering with gastric ulcer or with gamma strains isolated from appendicitis and cholecystitis.

TABLE IV

Ulcer series

Agglutination of Serum of Patients with Proved Gastric Ulcer with Antigens of Various Gastric Strains

Agglutination Titre	Number of Patients
1–1280	3
1–160 or 320	46
1–80	63
	Total 112

Control series

Serum of Patients with Varied Types of Streptococcus Infections

Agglutination Titre	Number of Patients
1–40 or less	40

Ulcer Patients Serum Following Vaccine Therapy with Organism in Avirulent Stage *

Agglutination Titre	Number of Patients
1–10 and no agglutination	11

* *Note.*—The vaccine was made when the organism was in its avirulent O and R type (see text). It therefore did not excite agglutinin formation, but the ulcer must have become less active to show a reduction or absence of the agglutinins present before vaccine therapy. Vaccine has now been prepared from the organism in its S virulent stage.

3. The blood serum of 112 patients suffering with gastric, duodenal or gastrojejunal ulcer has shown a specific agglutination against the antigen of the gastric strain ranging in titre from 1–80 dilution to 1–1280. Control serum from patients suffering with other types of streptococcus infections has never shown agglutination in titre above 1–40. A

control serum was run with every test as well as a great number from patients suffering from streptococcus cellulitis, acute infectious arthritis and erysipelas.

The highest titre agglutination occurred in serum obtained from patients with perforated or bleeding ulcers, with less high titres in serum from patients who were under treatment, whose symptoms were minimum and whose ulcers were comparatively inactive, but always a higher titre than any control. It has so far been 100 per cent. perfect from the standpoint of diagnosis.

Furthermore, eleven patients from the Cornell Clinic, previously untreated, showing positive X-ray evidence of duodenal ulcer and whose blood serum showed a high titre agglutination, had the titre of the control serum agglutination at the end of a two months' course of vaccine from the gastric streptococcus. The vaccine contained two billion killed organisms to the cubic centimetre, the dosage consisting of 0.2 cubic centimetre to two cubic centimetres increasing every five days by 0.2 cubic centimetre. Their symptoms had completely subsided, but by X-ray their defect still remained. Medical

PLATE III

FIG. 6.—Last O stage. Most of colony in the R stage. Very little S element left. Culture 47B.

FIG. 7.—Complete stable colony. Culture 2.

treatment will do as well. Only over a longer course of time eliminating recurrences can any benefit be claimed.

4. Experimentally, it is not possible to produce an ulcer in the stomach of a dog by a single injection of a culture of the gastric streptococcus by any method used. Its pathogenicity, however, is illustrated by its ability to produce a small ulcer in the skin of the dog following intradermal injection. Injection beneath the skin has no effect.

Allow for a minute a brief résumé of the bacteriological difficulties encountered which have been known to all investigators since the original work of DeKruif on the phenomenon of dissociation. It has been witnessed by a number of observers working with a large variety of organisms and is now accepted as a phenomenon widely distributed in nature, concerning the validity of which there is no question. A remarkable summary of the entire problem has lately been made by Hadley.[6]

It is extremely important, however, for the same thing may happen in the human body and is the result of favorable or unfavorable environment, especially p^{H}.

Although a single cell study has not yet been made, the difficulties encountered in this investigation, which has been a single colony study, would suggest that it is entirely due to this phenomenon of dissociation and not because more than one strain was present, or that it is due to contamination of cultures, or an evaporation phenomena, the latter

of which has been disproved by comparison of growth under constant conditions of moisture.

With the gastric strain the hæmolytic, antigenic and agglutinogenic reversals arise as the S (smooth) type changes to the R (rough) type of colony growth and O (intermediary) types under the influence of age and method of cultivation. When the organism was first recovered alpha prime hæmolysis was always present and in one case beta hæmolysis was present. After the second or third generation under the conditions of artificial cultivation, O and R forms become more prevalent and there is no hæmolysis even though *identical* blood plates are always used.

Antigenic and agglutinogenic power diminishes when colony growth reaches the intermediary O stage and vanishes with the R stage. The centre of an O colony shows many dead organisms, the edge daughter colonies living.

A lactose purple agar plate will show evidence of extremely active fermentation when the organism is in the complete R stage and only slightly when in the S stage.

The organism when in the S stage is virulent, for extremely small graded doses of a living culture are necessary to build up the titre of rabbits' serum because larger doses kill, while huge intravenous doses of the live culture in the R stage will not affect the rabbit nor can a serum titre of any degree be obtained. It has been demonstrated with other organisms that phagocytosis occurs only when these organisms are in the R stage.

Morphologically, the organism varies in each stage. Single and diplococci with few chains are noted in the S stage, short and long chains in the intermediary stages and small clumps in the R stage. The organism morphologically closely resembles the enterococcus in the R stage but there is always marked greening and never has it become a gamma type. The organism has consistently fermented lactose, sucrose and salacin and other sugars only rarely. This factor, besides its inability to grow on whey agar, distinguishes it from the commonly found enterococcus.

When an O (intermediary) culture is transplanted daily in 10 per cent. ox bile broth it rapidly reaches the stable R stage. Media of lactose agar to which human bile from an ulcer patient has been added shows no growth with S phase when the amount is more than one cubic centimetre of bile to fifteen cubic centimetres of media. The organism in its S stage will not grow in bile broth media of the lowest dilutions no matter how many times it is replanted. Bile, therefore, must have some protective substance which has the ability to prohibit the growth of the S organism and to keep the O and R organisms in a non-virulent state. It is known that bile salts kill pneumococci. Whether it is this factor with the gastric streptococcus or a vitamin content of the bile would be difficult to say. This phase of the problem is now being investigated.

A patient who had had a gastroenterostomy for a proved duodenal ulcer and who was later reöperated upon for a marginal ulcer, at which time the gastroenterostomy was undone and the marginal ulcer not demonstrated, again came to operation for positive X-ray diagnosis of duodenal ulcer. The duodenal ulcer, however, could not be demonstrated after cutting into the stomach. There were two large glands on the lesser curvature which were cultured. The alpha streptococcus was recovered and when first plated was in the complete R stage. This supports the belief that the same thing happens *in vivo* as *in vitro* for the ulcer was healed but the organism was there in its non-virulent form.

The clinical aspect of ulcer is well known. It runs truer to anthropological type than any other disease; it is definitely seasonal; it is chronic; it closely follows the course of other chronic infectious diseases in its characteristic periods of quiescence and recurrences over a long period of time; an excellent comparison is offered by osteomyelitis.

Experimentally, the only method by which ulcers have been produced

comparable to those found in man has been by the method of surgical duodenal drainage.

It is possible that the protective substance in bile, whatever it may be, has been removed and a normally non-virulent organism in its R stage becomes S and virulent. Attempts are now being made to maintain the stability of the S type and to reconvert the R type back to its S type, as Dawson[8] has done with the pneumococcus.

One can only surmise in the ulcer patient whether there is something deficient in their bile or whether there is not enough bile for protection. Failure of regurgitation of bile into the first portion of the duodenum and stomach may be at fault, due to the sharp duodenal angle.

Women suffer from ulcer rarely and then usually in combination with gall-bladder disease.

It is a common occurrence to have a previous duodenal ulcer recur when a gastroenterostomy previously performed for its cure is unhooked because of recurrent symptoms but no ulcer demonstrable.

The operations giving the most satisfactory results are those in which the bile is mechanically put back into the stomach, and four duodenal and one gastric ulcer, in patients in whom a gastroenterostomy was present, have given the only negative cultures.

There are over one hundred reported cases of perforated duodenal ulcer in marasmic babies from one to six months of age. Helmholz[10, 11] has demonstrated the infectious origin in many of them. They certainly do not have any foci of infection but they could be deficient in the physiology of their bile which prohibits the growth of the gastric streptococcus.

It has previously been stated that five of the ulcers, or 26 per cent., of the series of nineteen had undergone malignant degeneration. The organism's marked degree of transforming glucose into lactic acid has been noted. Because of the work of Otto Warburg[7] on lactic acid formation by the tumor cell, accurate analysis of the exact amount of lactic acid formed by the organism was done by the Laboratory of the Russell Sage Institute under the supervision of Doctor Shorr. The method used was that of Friedemann, Shaffer and Cotonio.[12]

R strain 64 and R strain 68 in 0.1 per cent. glucose broth containing 7.3 milligrams of glucose, in a twenty-four hour growth produced .59 and .68 milligrams of lactic acid, which shows that from 80 to 93 per cent. of the glucose was transformed into lactic acid by the organism.

A comparison of lactic-acid production by R strain 64 and S strain 68 in 1.0 per cent. glucose in a twenty-four hour growth showed that out of the 75 milligrams of glucose present, R 64 produced 3.37 milligrams of lactic acid, and S 68, 1.53 milligrams or approximately 4.5 and 2.1 per cent. respectively. Therefore lactic acid produced by the R strain is 100 per cent. greater than that produced by the S strain.

The 0.1 per cent. dilution of glucose approximates the glucose content of the blood and a greater degree of glycolysis resulted than with the 1.0

per cent. dilution which contained more glucose than the amount of growth of the organism could reduce.

Because the organism grows best under anærobic conditions, its energy probably is derived from glycolysis and very little from oxygen consumption. This is the type of metabolism of the carcinoma cell.

Part of the lactic acid found in the stomach contents in carcinoma of the stomach could be due to these organisms.

It is possible that the lactic acid produced by the organism in the ulcerated lesion may be a source of constant irritation to the tissue which may, after a long time, cause a transformation of normal into carcinomatous tissue as a number of the irritants are able to do, or possibly prepare the normal cell with lactic acid which Bierick, quoted by Warburg, believes is necessary for the spread of carcinoma.

Although lactic acid is formed by other intestinal organisms they do not produce lesions and therefore are not a source of irritation to the tissue. In muscle and retina, *etc.*, the lactic acid formed is buffered by good blood supply making neutral sodium lactate. A chronic ulcerated lesion has extremely poor blood supply and poor lymph return. The normal p^H of the tissue is also altered in the chronic lesion, also any buffer present might be exhausted by the Hcl. of the stomach.

Further investigation of this problem is now being carried on.

SUMMARY AND CONCLUSIONS

A summary of the facts which favor an infectious etiology of ulcer of the stomach are:

1. A streptococcus has been isolated from nineteen resected gastric, duodenal and gastrojejunal ulcers and proved to be identical and specific by differential cultural tests and by agglutination, cross agglutination and agglutinin absorption.

2. Its agglutinogenic and antigenic identity with similar strains producing ulcers of mucous membrane and skin has been demonstrated and likewise its non-identity with strains from foci of infection and appendicitis and cholecystitis has been shown.

3. Patients suffering from gastric ulcer have this organism's specific agglutinins in their blood serum in 100 per cent. of cases tested, while those suffering from any other type of streptococcus infection fail to agglutinate it or only in low titre.

4. The organism is apparently present in the lesion in immediately prepared Levaditi tissue sections.

5. The organism undergoes dissociation S (virulent) to R (non-virulent) under artificial cultivation and the possibility of it doing likewise *in vivo* has been demonstrated.

6. The S (virulent) form will not grow in bile in low dilutions and the o (intermediate) form rapidly becomes R (non-virulent) under bile cultivation.

7. Surgical procedures which return bile to the ulcer-bearing area give the best clinical results.

8. The marked degree of lactic-acid formation by this streptococcus has been noted and its relationship to carcinomatous degeneration suggested.

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ACUTE ULCERATIONS OF THE STOMACH IN CHILDREN

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Acute, fatal ulcerations of the stomach in children are sufficiently rare to warrant the report of the following case, with a review of the literature of the condition.

Case Report.—C. C., female, aged twenty-two months, was admitted to The Babies Hospital January 26, 1930, with the complaint of frequent vomiting during the previous thirty-six hours. She was the only child of young and normal parents. She was a full-term baby, vertex presentation, and weighed seven and one-half pounds. The history failed to disclose any past serious illnesses, injuries or operations. There were no abnormal symptoms referable to the stomach or duodenum.

Present illness.—Two days before admission the child was slightly flushed and seemed feverish although she continued to be playful and ate well. At night, however, she was restless. The day before admission, she started to vomit and refused to take food. All fluids given by mouth were immediately vomited. The vomitus was always watery and never contained blood or fecal material. The baby slept poorly and was very restless although the mother thinks that the child had no fever. On the day of admission the mother noticed that the child's abdomen was swollen and tender but she never complained of abdominal pain. There had been no defecation for two days. An enema the night before admission and another on the day of admission gave small fecal returns. For several days the baby had had a running nose but there were no other symptoms of an upper respiratory or pulmonary infection. There were no genito-urinary symptoms.

Subsequent questioning of the father revealed the fact that three or four days before admission the child was playing with a glass bottle which broke. When the parents tried to assemble the pieces it was found that a small portion was missing. The baby had the habit of putting all sorts of things in her mouth and it is the belief of the parents that she may have swallowed this missing piece of glass.

The patient was a well-developed and well-nourished female of twenty-two months. The skin was pale, cold and dry. The eyes were sunken. She was restless, picked at the bedclothes, and pulled at her mouth and throat. The respirations were labored and grunting but not rapid. The legs were drawn up at the hips. The head, neck, lungs and heart showed no important abnormalities. The pulse rate was 200 per minute. The abdomen was very full and distended and small dilated veins were present over the upper part. The liver dullness was completely obliterated. The liver and spleen were not palpable and no masses could be felt. There was marked dullness in both flanks and above the pubis and this dullness shifted with change of position. A fluid wave was present. No localized tenderness could be elicited although palpation seemed to cause pain. The external genitalia were normal. Examination by rectum revealed no masses or tenderness. The patellar reflexes were normal.

The respirations were 24 per minute and the admission temperature was 99.6°F. The white blood corpuscles were 8,400 per cubic millimetre, and showed 60 per cent. polymorphonuclear leucocytes, 38 per cent. small lymphocytes and 2 per cent. large mononuclears.

A milk and molasses enema given shortly after admission showed a small fecal return.

ULCERS OF STOMACH IN CHILDREN

The diagnosis of peritonitis with possible ruptured viscus was made and laporatomy was decided upon. Under novocaine anæsthesia, a right rectus incision was made and the abdominal cavity opened. A quantity of air, together with about 2,500 cubic centimetre of fluid, escaped. The fluid was dark brown in color and contained numerous food particles, curds of milk and globules of oil. The peritoneum was everywhere injected but there was no purulent exudate. The small intestines and colon were collapsed and contracted. The appendix was normal except for peritoneal injection. The lesser peritoneal cavity was bulging with undigested food. The child ceased breathing during the exploration of the abdomen. The anterior stomach wall was opened and a perforation about three centimetres in diameter was found on the posterior wall of the fundus. The edges were ragged, soft, frayed-out and deeply hæmorrhagic. No foreign body was found. Sections for microscopic study

FIG. I.—Photograph of a portion of the stomach. On the upper border is a part of the ulcer, showing the thin, hæmorrhagic and frayed out edges.
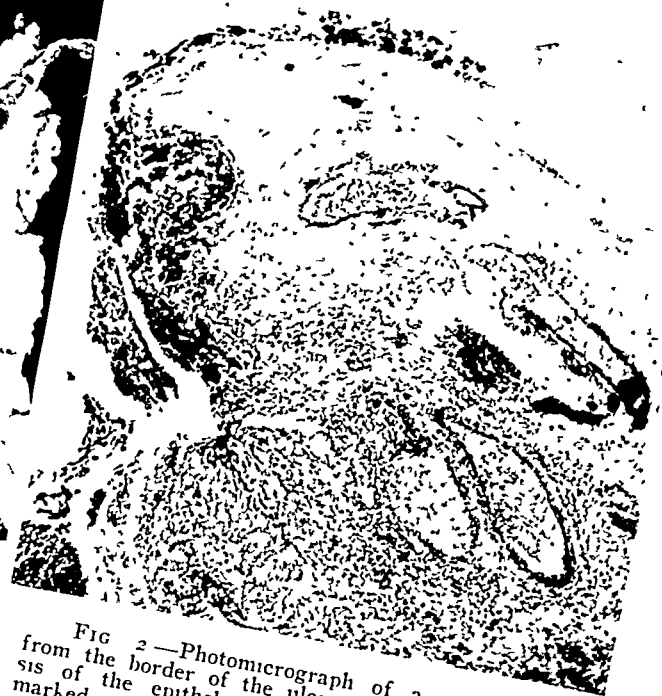
FIG. 2.—Photomicrograph of a section taken from the border of the ulcer at operation. Necrosis of the epithelium, together with œdema and marked polymorphonuclear infiltration of the submucosa is shown. The vessels contain fresh thrombi.

were cut from the edge of the perforation and fluid from the peritoneal cavity was saved for chemical analysis.

"The autopsy was done by the medical examiner who found nothing pathological in the heart and lungs. The peritoneal cavity contained a large quantity of fatty fluid with kernels of yellow corn. The stomach showed a round hole five centimetres in diameter in the posterior wall near the fundus (Fig. 1). Surrounding the ruptured area there was a dark red hæmorrhagic zone, but beyond that the mucosa was apparently normal. No foreign body was found in the stomach, intestines or abdominal cavity. The intestines were normal throughout and no blood was present. The liver was moderately fatty. The spleen weighed eighty grams. It was enlarged, firm, with prominent Malpighian bodies. The thymus was not enlarged. It weighed twelve grams. Microscopic examination of a section which included the hæmorrhagic edge of the tear and a narrow adjacent area of gastric wall (Fig. 2), which appeared to be normal, revealed necrosis of the mucosa; swollen, œdematous submucosa in which lay several thrombosed vessels. In the adjacent area of mucosa thrombosed capillaries were present

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between the glands which were in various stages of disintegration. merging into a normal mucosa. The muscle coats were œdematous and infiltrated with polynuclear leucocytes which were also present in large numbers around congested blood-vessels in the submucosa. A fold of mucosa with normal glands showed œdema of its submucosa and congestion of its vessels extending beyond the area of thrombosis.

Another section taken at the medical examiner's autopsy showed a fibrinous exudate on the serosa and polynuclear infiltration of all the coats with marked œdema and a fairly well-maintained mucosa.

This looks like an acute ulcer with secondary inflammation of the gastric wall, although the presence of a previous gastric lesion cannot be excluded." (Dr. Martha Wollstein)

The subject under discussion is acute ulceration of the stomach in children under ten years of age. By ulceration we mean a destructive process which involves not only the mucosa but also a portion of the submucosa and muscularis and which in certain instances may progress so as to involve the serosa. Erosions on the other hand never extend beyond the mucosa. It is this question of depth which separates the erosions and the true ulcers into two large and distinct groups.

Ulcers can further be divided into those which are acute and those which tend to run a chronic course. The acute ulcers are sudden in onset, produce marked and often alarming symptoms in previously supposedly well children and progress rapidly, either to healing or to perforation. Severe hæmorrhages are common.

The chronic ulcers of childhood are entirely different. They are similar pathologically to the ordinary chronic ulcers of adult life and also give rise to the same group of chronic but often more mild gastric symptoms. These chronic ulcers of childhood show the same indurated, infiltrated and sharp edge which is typical of those of adult life. The base is often composed of only a thin layer of muscle and serosa and perforation is not uncommon. The latter, however, differs from the perforations of the acute ulcers in that it is usually small and is situated in the center of a well-formed crater. In this paper, chronic, indurated gastric ulcers of childhood will not be discussed.

Etiology of acute ulcers.—Hæmorrhagic erosions of the mucosa and acute ulcerations of the stomach wall have long been considered to be closely related conditions. In both there is a local disturbance of circulation which in the true erosion is limited to the mucosa. In the ulcerative process, the vascular lesion extends deeper and involves the underlying layers of the stomach wall. To this disturbance of circulation is added complete or partial digestion of the infracted area. The sequent of events, therefore, in acute ulceration of the stomach is hæmorrhage, followed by gastric digestion. Because of the importance which digestion plays in the production of these necrotic lesions, Virchow [1] proposed to call them "corrosive ulcers." Simple and uncomplicated autolysis of the stomach wall is not to be considered.

The causes of the vascular disturbance are another and more obscure matter. They will be discussed separately under the six headings of con-

gestion, embolism, thrombosis, direct vascular injury, vascular diseases and diseases of the nervous system.

I. *Congestion.*—Congestion of the arterioles and venules which is so extreme as to cause rupture followed by hæmorrhage into the tissues is probably the most important single cause of erosions and acute ulcerations of the stomach. The high incidence of such lesions in new-born infants points to the fact that the extreme congestion of all of the abdominal vessels associated with the process of birth is shared by the smaller vessels of the stomach and duodenum and in some of these the pressure is sufficient to cause rupture. In Theile's [2] series of 248 cases of ulcers of the stomach and duodenum in children, 138 occurred in the first year and of these, 83 or one-third of the entire series were found in the first month of life. Butka [3] in 1927 was able to find only three cases of ruptured gastric ulcers in infants under two months of age reported in the literature, although Theile,[2] as early as 1919, was able to collect thirteen such cases. The average age of twelve of these patients was five days, while the thirteenth was seven weeks old. Later in life congestion can be caused by numerous other factors, notably heart disease and cirrhosis of the liver, but ulcerations of the stomach in children with these diseases is not a common or noteworthy finding at autopsy. Talma [4] was able to produce hæmorrhages in the gastric mucosa of rabbits by simple over-distention of the stomach. Following this, there was softening due to digestion with subsequent necrosis and perforation. In an admirable paper by Busch [5] on so-called spontaneous rupture of the stomach, published in 1924, it is pointed out that over-distention or acute dilatation is the commonest predisposing cause in these cases and that the majority have occurred in harvest time due to over-eating of easily fermented fruits and undue consumption of beer. Busch at the same time stresses the fact that other possible causes of rupture, such as carcinoma, chronic ulcers, inflammation of the vessels and thrombosis, must be eliminated before spontaneous rupture of an otherwise normal stomach can be considered. In the patient here reported, thrombosis of the vessels does exist, although there is every reason to believe that over-distention was also present.

II. *Embolism.*—Embolic occlusion of a vessel in any part of the body is possible from any given source. That such lesions in the stomach can occur *cannot be denied, or even doubted, although their incidence, judging from* the recorded cases, is probably low. Theile [2] collected five cases of ulcers of the stomach in children which appeared to be related to infectious processes in other parts of the body. Two of these were in patients with pneumonia and one each in patients with typhoid fever, measles and scarlet fever. In a series of 165 cases of hæmorrhagic erosions of the stomach which Beneke [6] reported, 66 per cent. were found in non-septic individuals. Schwartz,[7] in 1929, reported three cases in which punched-out or indefinite openings were found in the stomach. The edges of all three of these were exactly as if a hole had been punched out of an area of indefinite inflammatory tissue. In discussing these, he says that it is difficult to speak of an early ulcerative

process and it is better to consider it at a circumscribed necrotic change, the result of rapid and increasing disturbance of nutrition or blood supply to a localized area, the cause most likely being an embolus. No proof for this assumption is given.

Ulceration of the stomach secondary to emboli from an active endocarditis has not been observed in children.

Emboli from the rapidly thrombosing umbilical vein have been considered by Landau [8] to be the cause of the vascular lesions of the stomach and duodenum which have already been mentioned as being frequent in very young infants. He traces these emboli from the venous circulation through a patent ductus botali into the systematic arterial circulation. Such an hypothesis is tenable, although highly speculative.

III. *Thrombosis.*—At the present time, little is understood of thrombosis in any part of the body and a discussion of the various theories of its causes and predisposing factors need not be entered into here. Retrograde thrombosis from other lesions in the peritoneal cavity is perfectly possible and is rather frequently observed following acute suppurative appendicitis. In these cases it need not necessarily be a suppurative process.

Theile [2] devotes considerable space to chronic gastric ulcers occurring in marasmic and weak infants, although no definite exciting cause is mentioned. In four of his collected cases there was perforation of the ulcer. In the 65 cases of duodenal ulcer in Holt's [9] series in which the age was given, 70 per cent. of the ulcers occurred between the ages of six weeks and five months, the greatest incidence being between the sixth and tenth week. Holt says that "the age incidence is very striking. It corresponds very closely with the age incidence of deaths from marasmus." Can not these be due to thrombosis in veins filled with blood which is stagnated as the result of a weakened and inadequate circulation?

Thrombi are present in the vessels of the stomach wall in the case here reported. Whether they are primary or were formed secondary to some underlying and more fundamental process is a matter of opinion only. Definite causes of thrombosis, such as we know them to be, are, in this patient, lacking. We know of no altered chemical reaction of the blood, altered metabolism, slowing of the circulation or injury to the intima of the vessels, although it is futile to deny any or all of these. Such a discussion leads to no end. It is, however, the fact that thrombi were demonstrated in this patient in the vessels in the region of the destructive process in the wall of the stomach which I wish to record.

IV. *Vascular Disease.*—Diseases of the vessel walls can be dismissed without discussion. In adults, changes due to endarteritis and endophlebitis or to hyaline, amyloid and fatty degeneration of the vessel walls might possibly play a rôle in the etiology of ulcerative lesions in the stomach, but in children these changes are of the utmost rarity and the possibility of their occurrence is mentioned only for the sake of completeness.

V. Direct Injury to the Mucosa.—Direct injury to the gastric mucosa and underlying blood vessels by caustic and acid solutions, foreign bodies and coarse particles of food must always be kept in mind. These are things which are easier to prove than they are to disprove. In the patient reported, there is a definite history of her having had access to broken pieces of glass three or four days before her death, but at operation and autopsy no foreign bodies could be found, although a careful search for these was made. Chemical analyses of the free fluid in the peritoneal cavity failed to disclose the presence of poisons and there was nothing else in the findings to suggest the ingestion of such substances.

Under the heading of local injuries of the mucosa of the stomach must be noted the tuberculous ulcers which are probably due to the ingestion of tubercle bacilli. Theile [2] collected twenty-one such cases of tuberculous ulcers in the stomach and duodenum of children. One of these in the stomach had progressed to perforation.

VI. Nervous Influences.—The neurogenic theory of the origin of vascular occlusion is the one which is included as the final "catch-all" for any case which will not with ease fit into the other groups. It need not detain us long. Spasm in health or disease may occur and this may presumably be limited to certain local areas in the stomach wall. Hauser [10] mentions brain diseases under the causes of hæmorrhagic erosions, but the exact proof of their relation to these changes is not given.

Course.—Hæmorrhagic erosions of the mucosa of the stomach in infants is of rather frequent occurrence and the majority of these progress to healing. Acute ulcerations, on the other hand, are more violent in onset, involve a greater area and depth of tissue and, as a rule, run an acute course, leading in a short time to perforation (Hauser [10]). This tendency to perforation led Rokitansky [11] in 1842 to suggest the name of "perforating stomach ulcers" for these acute lesions. Theile [2] and Hauser [10] both think that in some instances the reparative process may be sufficient to turn these sudden and destructive lesions into ordinary ulcers of the chronic type.

SUMMARY

An acute, fatal, perforated ulceration of the stomach wall is reported in a female infant of twenty-two months of age. The history of ill-health for only two days, the site of the ulcer on the posterior wall near the fundus of the stomach and the lack of all signs of a chronic ulcer lead one to assume that the changes noted are of an acute and rapidly destructive nature. The markedly hæmorrhagic edges of the necrotic area suggest that the primary lesion was one of hæmorrhage, either from local injury, over-distention, or vascular thrombosis, and that gastric digestion of this area caused the perforation. This case is of especial interest in that the perforation was found and measured at operation before post-mortem digestion became manifest.

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ANNULAR PANCREAS, INVOLVED IN ACUTE HÆMORRHAGIC PANCREATITIS

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As far as I have been able to ascertain, the literature has never contained reference to a case at all similar to the one reported in this article.

Case No. G-1526.—The patient, a negro male, aged thirty-five years, a common laborer, entered the Receiving Hospital, January 28, 1929, with an admission diagnosis of (1) chronic nephritis, (2) cardiac hypertrophy, and (3) secondary hypertension. His chief complaint was headache and stomachache. He had felt well until last summer when he began to have pain in his head, throbbing in character, beginning late in the afternoon and lasting the whole night. At about that time, following a sensation of fullness in the head, there was severe nosebleed lasting for ten minutes, leaving him weak. Following this he felt well again until January 24, 1929, when there was noticed slight bleeding from the nose followed by throbbing headaches in the left temporal area, with some shortness of breath and weakness. The shortness of breath had been intermittent since last summer. There had been nocturia for the past three years beginning as two times and now six to eight times. His urine had been light in color and its passage had caused pain and burning for seven months previous to admission and there was also some incontinence since last summer, but no retention. He had been a heavy alcoholic drinker for the past three years until three months ago, consuming one and one-half pints of hard liquor daily. The family and marital histories were unimportant.

Fourteen years ago the patient had a chancre and gonorrhœa. During 1927 he suffered from an attack of parotitis and hæmaturia. In 1928 there was a history of blood-streaked sputum, night sweats lasting for one and one-half years and loss of twenty pounds in weight since June of the same year.

When admitted he was well nourished and well developed. He was apparently not very ill. The teeth showed caries and there was a slight enlargement of the cervical glands. There was limited excursion of the chest wall and diminished elasticity and density of lung tissues. There were no râles or areas of consolidation. A systolic murmur was heard in the third and fourth interspaces with a ringing aortic second sound. The heart boundaries were within normal limits and the blood pressure was 240 millimetres mercury systolic and 170 diastolic. His abdomen in its right upper quadrant showed some tenderness. The liver was not palpable and there was no rigidity nor were there palpable masses or enlarged inguinal glands. The reflexes were normal. The temperature averaged 99° F., pulse 90 per minute and respirations 20 per minute. The specific gravity of the urine was 1.018 to 1.016 with 3 plus to 2 plus albumin and 1 plus white blood cells, no red blood cells, a few hyaline and granular casts at one examination and a few hyaline casts at another. Blood tests gave hæmoglobin 90 per cent. (Sahli), red blood cells 4,250,000 and white blood cells 6,300 to 7,200 with 79 per cent. and 80 per cent. polymorphonuclears. The Kahn and Wassermann tests were negative. The blood nitrogen was 39 milligrams per 100 cubic centimetres and blood urea 32.9 and blood dextrose .11 per cent. The renal concentration test showed the highest specific gravity to be 1.020 with an intake of 1,500 cubic centimetres and an output of 500 cubic centimetres in five hours. A skiagram showed the left ventricle and auricle enlarged. There was practically no hypertrophy of the right auricle.

In February of 1929 there was some improvement, but there was complaint of lack of appetite and considerable abdominal pain, the latter lasting for two days. On February 14, 1929, the patient was discharged.

February 21, 1929, the man was re-admitted to the hospital. The symptoms at this time were those of an acute illness with vomiting of coffee-ground material, rigidity and tenderness of the abdomen, particularly in the right upper quadrant, and severe cramps in the epigastrium and about the umbilicus, protracted through the previous five days and increasing in severity, compelling him to go to bed. The pains were non-radiating in type. The bowels had been constipated for four days but without distention of the abdomen. The patient was in a state of collapse. Palpation revealed an indefinite mass the size and shape of a hen's egg in the right upper quadrant. The temperature at this time was 96.8° and the pulse was rapid. The systolic blood pressure was 130 millimetres mercury and the diastolic 98. The blood nitrogen was 129 milligrams per 100 cubic centimetres, uric acid 12.4 and creatinine 4.

Operation.—It was decided that an acute intra-abdominal surgical condition existed
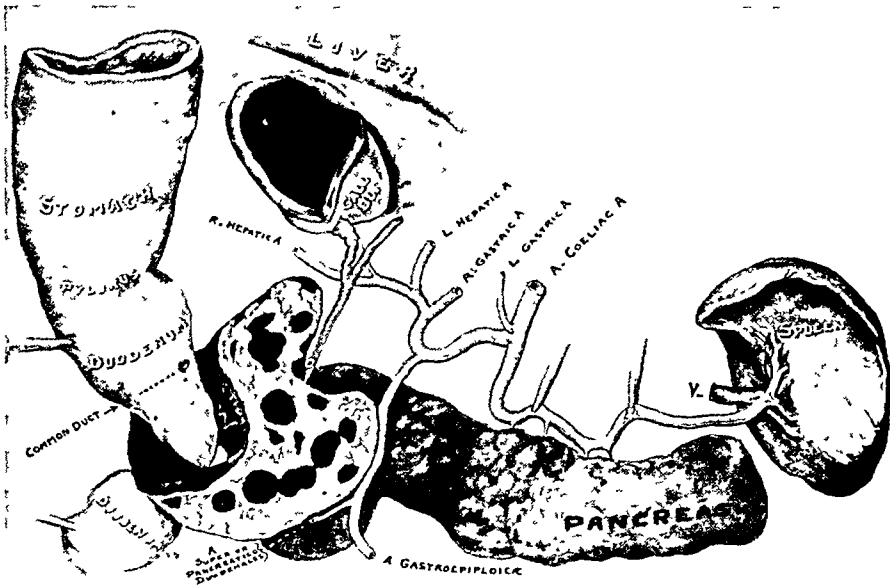
FIG. 1.—Annular head of pancreas

which was either intestinal obstruction or a walled-off perforated gastric or duodenal ulcer, as there was a definite mass palpable over this area. The abdomen was examined through a four-inch right rectus incision. No free blood was found in the peritoneal cavity but there was extensive sub-peritoneal hæmorrhage involving the cæcum, ascending colon and four feet of the ileum. A massive retroperitoneal hæmorrhage had occurred about the duodenum dissecting beneath the peritoneum as far as and into the pelvis. The hæmorrhage was confined to the right side of the abdomen. The omentum had migrated to the hæmorrhagic area in the right upper quadrant where the retroperitoneal blood had formed a clot measuring about 10 centimetres in diameter. The patient's condition during operation was very poor and stimulants were given. The abdomen was closed with drainage. The patient died one hour and forty minutes later.

Autopsy.—The examination was made twelve hours following death. The cranial cavity showed no pathology. The lungs were essentially negative. The heart was considerably enlarged, the enlargement being due principally to thickening of the left ventricular wall. The valves showed no pathology.

When the abdomen was examined extensive hæmorrhage was found to have occurred beneath the parietal peritoneum on the right side producing bulging into the abdominal cavity. The peritoneum was removed and the hæmorrhage found to be most extensive

about the duodenum. The spleen and body and tail of the pancreas were explored and found to be normal. Blood clot containing considerable fibrin was removed from about the duodenum with difficulty because of the close adherence of the clot. *The head of the pancreas was unusually large and attached to, and apparently growing out from, the anterior aspect of the head and uncinate portion there was a ring-shaped process which completely encircled the proximal end of the descending portion of the duodenum.* (Fig. 1).

Each arm of the annular portion of the pancreas at its attachment to the head measured 2.5 centimetres in its greatest diameter which diminished to 1.5 centimetres at the point most distant from the pancreas proper. The lumen of the annular part measured 2.5 centimetres in diameter, sufficient to allow the duodenum to pass through without constriction. The duodenum proximal to the pancreatic ring, as well as the pyloric ring and stomach, were somewhat distended but this distention was probably recent and due to pressure from the hæmorrhage rather than to a constriction from the annular process. In nearly all reported cases of annular pancreas there was constriction of the duodenum
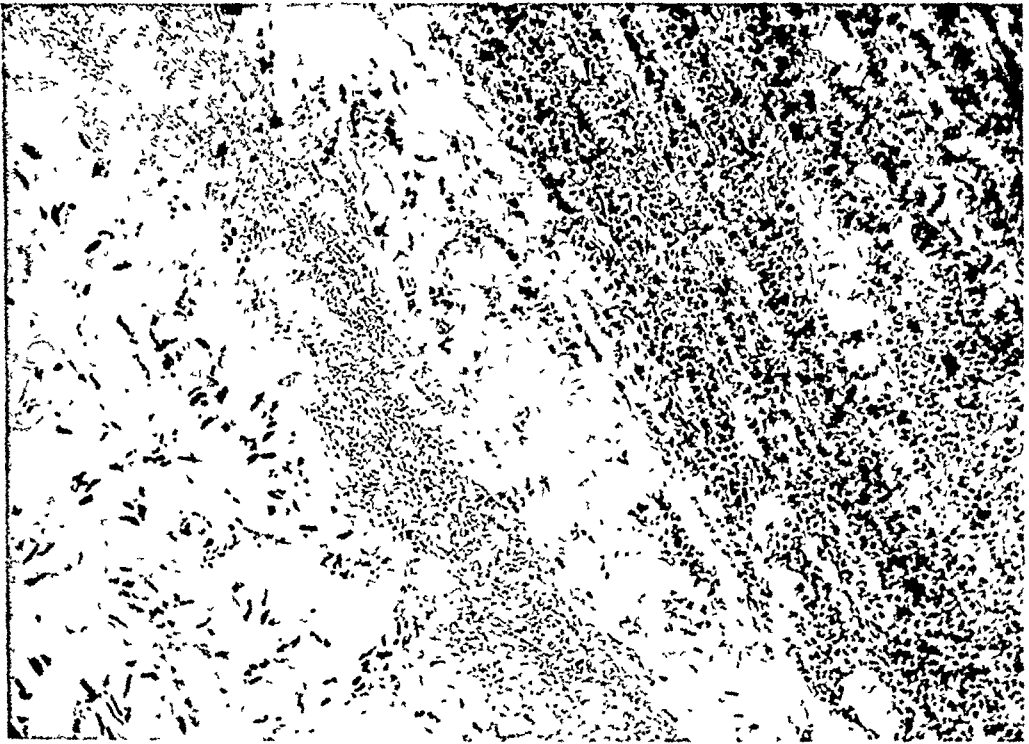
FIG. 2.—Hæmorrhage, necrosis and leucocytic infiltration.

with consequent dilatation and hypertrophy of the stomach and duodenum proximal to the constriction.

The cystic duct was larger than the hepatic duct, approximating in size the common duct. The cystic, common and pancreatic ducts were somewhat enlarged and were without flexures or angulations. A common bile and pancreatic duct 2 millimetres in length entered the duodenum at the ampulla of Vater. There was but one pancreatic duct which continued without branching for 18 millimetres after entering the pancreas at a point corresponding to an imaginary line of fusion between the pancreas proper and the annular portion. The blood supply of the additional pancreatic tissue was derived principally from the gastroduodenal artery and its superior pancreatico-duodenal branch as well as branches of the inferior pancreatico-duodenal branch of the superior mesenteric. There was an increased number of pancreatic rami of the splenic artery. No accessory branches of the hepatic artery were found.

The enlarged or left side of the pancreatic ring, adjacent to the head, appeared swollen and was somewhat softer than the remainder of the pancreas.

The surface of this portion possessed a red congested appearance and this color spread to the entire surface of the annular pancreas and also to the head and a portion of the body of the horizontal pancreas. Sectioning the organ in the transverse vertical plane, the swollen portion contained numerous areas of hæmorrhage, spherical in shape, measuring from 0.5 centimetre to 1.5 centimetres in diameter. One especially large hæmorrhagic area had ruptured through the capsule, covering the inner aspect of the ring toward the left side of the duodenal wall. This area of rupture communicated with the large mass of blood in the retroperitoneal space. The escaping blood had dissected downward beneath the parietal peritoneum as far as the pelvis and also beneath the visceral peritoneum covering a portion of the bowel, especially the cæcum and ascending colon. The hæmorrhagic areas were confined to the annular portion and the head, except for a single area 7 millimetres in diameter in the tail. Absence of fat necrosis was conspicuous, but it must be remembered that the peritoneum was intact. The gall-bladder was normal in size, but was pale in color and the wall was thickened to ¾ millimetre. There was localized thickening of the gall-bladder wall on the liver side, producing a single, well-circumscribed elevation of 6 millimetres in diameter projecting into the lumen. Here it might be reiterated that the cystic, common and pancreatic ducts were enlarged, straight and continuous, forming an easy pathway for possible infection to travel through the
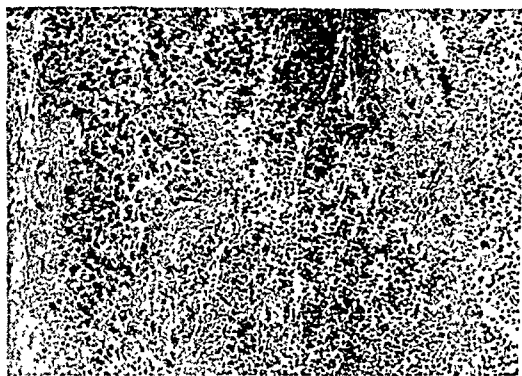
Fig. 3.—An area of suppuration and necrosis.

Fig. 4.—Perilobular fibrosis, lymphocytic infiltration and thrombosis. This is a typical area exhibiting chronic inflammation.

ducts from the gall-bladder to the pancreas. The gall-bladder and ducts contained no calculi.

The liver, spleen and entire gastro-intestinal tract were otherwise negative. The prostate was not enlarged. The kidneys were about one-half normal size, pale and fibrous with coarsely granular surfaces. The cut surfaces showed marked connective tissue increase.

The microscopic pathology of the pancreatic tissue can be divided into four interrelated states: 1. An old inflammatory process characterized by marked interlobar and interacinar fibrosis associated with lymphocytic infiltration. 2. Dense pus cell infiltration associated with early necrosis in the central portions of lobules. 3. Larger areas of necrosis involving several lobules with a peripheral zone of purulent exudate. 4. Old and recent hæmorrhage. The recent hæmorrhage was the most extensive, and was associated principally with the large necrotic areas and had probably existed only a few hours before death. The older areas of hæmorrhage were surrounded by a wall of connective tissue, contained hæmosiderin and probably had existed several days.

The gall-bladder wall showed the presence of active chronic cholecystitis.

Discussion.—Differences of opinion exist regarding some minor points in the embryological development of the pancreas. The pancreas develops from cells in that portion of the foregut which later becomes duodenum, differen-

tiating and forming two anlagen in the embryo of 0.75 millimetres in length. The dorsal anlage begins as an outpouching or diverticulum on the duodenum while the ventral an'age arises as a grooved bud from the common duct at its juncture with the duodenum. It is thought that occasionally there are two anterior buds which soon fuse into one. The pancreatic buds are opposite to and appear later than the living buds. These processes grow into the surrounding mesoblastic tissue which forms the capsule and trabeculæ. At first the pancreas is covered by the two layers of mesentery, but as fusion of the mesogastrium and transverse mesocolon occurs, the posterior layer of the mesenteric fold is absorbed, leaving the pancreas behind the peritoneum. In the beginning the hepatic and pancreatic ducts are separate and on opposite sides of the duodenum, but later they approach each other and finally fuse. The anlagen grow separately until by the circumrotation and growth of the ventral anlage around the medial side of the duodenum they meet posteriorly where they coalesce and continue development in one mass in the dorsal mesentery. Up to this time the growth of the dorsal bud is much more rapid than that of the ventral. At first the pancreas is in an antero-posterior position and points upward, but later becomes transverse and horizontal. The dorsal portion of the gland, which is in close proximity to the common duct, corresponds to the ventral enlage which eventually forms the caudal portion of the head of the adult pancreas and the pancreatic duct. The larger portion, derived from the dorsal anlage, represents the remainder of the head and all of the body with enclosed ducts.

If the ventral diverticulum fails to rotate and develops without fusing with the dorsal bud, an accessory pancreas is formed which constitutes the most frequent abnormality of pancreatic development. The accessory pancreas, which is relatively common, is usually found in the wall of the stomach or duodenum and occasionally at the tips of diverticuli of the gastro-intestinal tract, in the formation of which they are supposed to play a part.[1] The accessory pancreas may also be attached to the peritoneal coat of the duodenum and is sometimes spoken of as the "pancreas minus." The "pancreas divisum" results as a separation of gland substance during development due to pressure from the vessels. The semicircular pancreatic process partially surrounding the duodenum is similar to and somewhat more common than the annular pancreas described in this paper. The two distal ends or glandular processes are sometimes connected by a band of fibrous tissue and the circle thereby completed.

Annular pancreas is an extremely rare developmental anomaly. Twenty-eight cases have been previously reported. Ecker[2] gave it the name it now bears in 1862 and is frequently credited with describing the first case at that time. In Smetana's recent article, however, Schirmer (Beiträge zur Geschicte und Anatomie des Pancreas, Inauguration dissertation, Basal, 1893) is quoted to the effect that Becourt demonstrated a case in 1830, and Moyse another in 1852. Auberg[3] reported a similar case four years after Ecker, Symington[4] another in 1885, and Generisch[5] the sixth case in 1890. Since then

cases have been reported or specimens exhibited by Thacher [6] in 1893, Sandras [7] in 1898, Summa [8] in 1900, Tieken [9] in 1901, Vidal [10] in 1905, Lerat (quoted by Huet),[11] Baldwin [12] and two cases by Lecco [13, 14] in 1910, Cords [15] in 1911, Benedetti [16] and also Gruber [17] in 1920, two cases by Kurozawa [18] in 1923, Susukida,[19] Shibata [20] and Keyl [21] in 1924, one case by Sugawra and Shibata [22] in 1925, one case by Thür [23, 24] and three by Smetana [25] in 1929.

To explain the formation of annular pancreas, two theories have been advanced. Due to rotation of the ventral bud, each anlage develops separately, producing pancreatic tissue on each side of the duodenum which might grow, fuse on approximation and eventually surround the gut. The other theory advanced, which is simple hypertrophy, a ventral and dorsal process extending from the head and meeting on the right side of the duodenum with fusion resulting from some "inherent biological force," is more readily understood because, first, there is no marked abnormality of blood supply or arrangement of excretory ducts; second, because the ring is thickest where it joins the head and thinnest on the right side which is most distant from the pancreas proper; and third, the pseudo-annular pancreas may be considered an early or arrested stage of the true annular pancreas, being incomplete because of insufficient hypertrophy.

Lecco [14] believes that the ring portion of the annular pancreas is the left portion of the dorsal pancreatic lobe which has been displaced to the right and he states emphatically that the annular pancreas cannot be explained as a simple, greatly exaggerated proliferation of pancreatic tissue but that its origin is dependent on a dystopic anomaly of the ventral anlage. Cords [15] thinks there is premature fusing of the ventral and dorsal anlage and during rotation of the intestine the ventral part is pulled out into a band. Smetana [25] believes that the theory of the persistence of a left ventral anlage is the most reasonable because it implies only a further development of tissue already present. He also calls attention to the possible development of an increased number of pancreatic buds around the duodenum inasmuch as coëxisting aberrant pancreatic tissue has been found in the gastro-intestinal tract in cases of annular pancreas. Sugawra and Shibata [22] call attention to the observation that annular pancreas is frequently associated with other anomalies in other parts of the body. In Keyl's [21] case there were other developmental defects including a kyphoscoliosis which he thinks might have influenced the shape of the pancreas. Baldwin [12] says "this ring of tissue is either a persistence of the left half of the ventral anlage or an excessive growth from the right half of the same anlage. If it is this latter case the excessive growth has taken place ventral to the duodenum and to the left at the time that the remainder of the same half was growing or being carried dorsally to ultimately fuse with the head of the gland."

Conclusions.—1. The case reported represents the coëxistence of a fairly uncommon inflammatory disease of the pancreas and a rare anatomical deformity of the pancreas which is recognized as a definite entity.

2. The acute inflammation of the pancreas in this case which was asso-

ciated with suppuration, necrosis and hæmorrhage was an exacerbation of an old chronic interstitial pancreatitis, in the presence of chronic cholecystitis.

3. It is possible that annular pancreas is the result of simple hypertrophy rather than an embryological defect, although the rather vague developmental theories are more strongly adhered to.

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After my experience, another almost identical case was observed at the Lenox Hill Hospital by Dr. Otto C. Pickhardt.

CASE III.—S. G., male, age thirty-nine years, was admitted to Doctor Pickhardt's service October 14, 1929. He had been in the hospital twenty-two months before, complaining of a severe pain in the upper abdomen radiating to the back from which he had been suffering on and off for the past three years. He had never been jaundiced. He had not been acutely ill and never had had any rise of temperature. Various examinations suggested the possibility of a duodenal ulcer. He was discharged after a two months' period of observation without any surgical interference. On his re-admission, he gave a history of having been quite well until four months previously, when he began to complain of a sensation of pressure in the right upper quadrant. This was followed by a deep, dull pain in the mid-epigastrium and back, radiating to the right side. Two weeks before admission, the pain became knife-like in character and of great severity. The patient stated that although he was twice shot in the abdomen during the war, he had never experienced such pain as he suffered from during the present attack. The pain then began to radiate to the right shoulder. He required large doses of sedatives. There was no nausea or vomiting. Examination showed a well-nourished individual. He was not jaundiced. There was tenderness on deep pressure in the epigastrium, but no rigidity. His pulse and temperature were normal. His blood count was normal. The urine showed no albumen or sugar. The icterus index was 4 to 5. He was operated on by Doctor Pickhardt October 16, 1929, with a pre-operative diagnosis of duodenal ulcer or possibly subacute cholecystitis. A relatively normal gall-bladder was found, except that there were a few pericholecystic adhesions. There were no calculi in the gall-bladder, ducts, or at the papilla. The foramen of Winslow was open. The head of the pancreas was found to be enlarged to the size of a plum, indurated and nodular, and the body and tail were much firmer than usual, but not so indurated as the head. There were several enlarged, hard lymph glands lying over the head of the pancreas and one of these was removed for microscopic examination. The gall-bladder did not seem sufficiently diseased to warrant cholecystectomy, but through the gastrocolic omentum, the peritoneum over the head of the pancreas was incised. This tissue was found to be much thickened, œdematous and bled profusely on incision. The area was drained by two cigarette drains. Microscopic examination of the excised lymph gland showed a chronic lymphadenitis with surrounding inflamed fat tissue. The patient made an exceptionally uneventful convalescence except that for a time he still complained of deep epigastric pain similar in character to that from which he had suffered before the operation. Up to twelve days after the operation, the urine contained sugar up to 0.7 per cent. For a time there was a mucopurulent discharge from the drainage sinus which, however, showed no active pancreatic ferments. Doctor Pickhardt reports that he has recently seen the patient, who has remained perfectly well since his discharge from the hospital. This case was also a clearly defined subacute affection of the pancreas, without definite gross involvement of the gall-bladder.

Following these cases, a paper by Archibald, of Montreal, appeared in the November, 1929, ANNALS OF SURGERY entitled "Acute Œdema of the Pancreas". His paper is based on some animal experimentation, and an observation, similar to the last two cases reported above, which he made during an operation in 1907. He is also of the opinion that there is a form of mild pancreatitis which may be a precursory stage of the much more serious acute hæmorrhagic or necrotic form, or of the chronic type of the disease, which might possibly be recognized, and which may be amenable to surgical treatment. He advocates cholecystostomy as the operation of choice.

How then can these various ideas and experiences be correlated into a

definite pathological and clinical picture? What are the pathological criteria by which subacute pancreatitis or so-called acute œdema of the pancreas may be established as a distinct entity? If it exists, what is its symptomatology, and how can it be differentiated from the acute or chronic form, and from other subacute conditions in the upper abdomen? Finally, if it can be diagnosed, how should it be treated?

Pathologically, in order to be grouped in this category, the pancreas should show only an enlargement and induration, largely due to œdema. If there is true suppuration, frank hæmorrhage, or actual necrosis, with the usual escape of pancreatic ferments and the formation of fat necroses, the case must be classed as belonging to the acute variety. In addition to the increase in size and thickening of the pancreas, the overlying peritoneum from the posterior wall of the lesser sac will be found to be œdematous and injected. Further, in order that the case may be considered clean cut, there should be no, or only very slight, gross disease of the gall-bladder. In the chronic form there is, of course, also an enlarged pancreas, but it is firmer and more fibrous, and there is no œdema or injection of the overlying peritoneum. The microscopic examination according to Zoepffel, as mentioned above, shows only inflammatory œdema of the gland without any necrosis of the parenchyma and without hæmorrhage.

From the clinical aspect, unless the case is obscured by a complicating active disturbance in the gall-bladder or bile ducts, the picture is rather characteristic. There is usually a definite history of previous recurrent attacks of pain, extending over a period of a few months to many years. In a study of the acute hæmorrhagic cases, it will be seen that with very few exceptions, there is such a history. In our small group, this history was obtained in twelve out of the fourteen cases, or 85 per cent. plus. In one of the cases no reference is made to previous attacks, and in one it is stated that the acute disturbance was the first attack. These attacks vary in severity and duration and, of course, subside spontaneously until the serious acute involvement occurs, or until a chronic pancreatitis is established. It might be argued that these previous attacks were attacks of biliary colic or cholecystitis. This is probably correct in certain cases, but in many instances, if the attacks are analyzed, they will be found to have a rather specific character, differing decidedly from the usual gall-bladder pain. Further, it will be seen that in some of the cases where there have been previous severe attacks, the gall-bladder is found relatively uninvolved—at least grossly. This was true in two out of our fourteen acute cases, and also in the subacute Case III reported above.

The pathognomonic symptom is an excruciating, deep, boring pain in the mid-epigastrium. In the last two cases reported here, this pain was of the severest character—and this feature has been confirmed by all the other observers. The pain usually radiates to the left, as emphasized by Katsch and as noted in Case II. This fact helps to differentiate the disease from a gall-bladder condition, or from a penetrating duodenal ulcer, but it is by

no means inevitable. In Case I, the main pain was in the right hypochrondrium, and this radiated to the back, due probably to the definite gall-bladder pathology. In Case III, the pain radiated to the right, probably because the principal involvement was in the head of the pancreas. Nausea and vomiting may accompany the pain but they are not outstanding symptoms.

The main objective sign is tenderness on deep pressure in the epigastrium with practically no, or only very slight, rigidity. The absence of real peritonism is obviously due to the fact that the inflammatory condition lies so deep in the abdomen that a *defense musculaire* is precluded. There is often a definite Head zone of hyperæsthesia in the left flank at the level of the eighth to the tenth dorsal. Except when there is a calculous or inflammatory common bile duct obstruction, due to a complicating cholelithiasis or choledochtitis, jaundice is usually absent and there is generally no increase in the icterus index figures. There is frequently a moderate rise of temperature and a slight elevation of the pulse rate, but this is not excessive, so that aside from the extreme pain, the patients do not appear acutely ill and the entire picture of the disease is definitely that of a subacute disturbance. There may be some leucocytosis, a trace of glycosuria, or a mild degree of hyperglycæmia. A decreased sugar tolerance may also be noted. An increase in the amylase or lipase content of the blood or urine may likewise occur. Finally, there may be a diminution or absence of the pancreatic ferments in the duodenal contents obtained by the duodenal tube.

This clinical picture should serve sufficiently to differentiate this disease from the two conditions with which it might most readily be confused, namely, a mildly acute or a subacute cholecystitis, and a penetrating gastric or duodenal ulcer. A negative X-ray examination of the gall-bladder, stomach and duodenum, which would be found in an uncomplicated subacute pancreatitis, should help to settle the diagnosis.

Assuming then that this type of pancreatitis occurs, and that it can be diagnosed, what is the proper therapy? I believe that early operative interference is distinctly indicated, both as a curative and as a prophylactic measure, even if the possibility of a subsidence of a particular attack exists. Contrary to the opinion rather generally held, I believe that, if a definite subacute pancreatic involvement is found, a cholecystectomy should be done in the majority of cases, even if there is no very decided gross lesion of the gall-bladder. I feel that the removal of the gall-bladder removes the main source of danger. The cystic duct stump area should certainly be drained in these cases, as leakage from explosion of the ligature is not improbable, but I do not believe drainage of the common bile duct is usually necessary. The only exception I would make to this indication is if the patient is jaundiced, which would point to a more chronic form of the pancreatic disease, and some obstruction at the papilla of Vater. In such a case the gall-bladder should be preserved and a cholecystostomy done with the intention of performing an eventual cholecystectomy when the jaundice has subsided and the biliary fistula has closed. A cholecystenterostomy or a cholecysto-

gastrostomy should be reserved for the frankly chronic cases with definite and more permanent occlusion at the papilla. On the whole, if the gall-bladder is not needed as a safety-valve, I think it is better to remove it because of the numerous disadvantages that follow in the wake of a retained, cholecystostomized gall-bladder which have been pointed out by many authors, and to which I have also called attention. In general, I believe that the possibility of the development of pancreatitis is just an additional point in favor of the removal of a diseased gall-bladder. Of course should calculi be found in the common bile duct or at the papilla, these should be removed with or without drainage of the duct, depending upon the presence or absence of a coëxisting cholangitis.

Though somewhat of a negative argument, it is an interesting observation and rather confirmatory as to the etiology and prophylaxis of acute hæmorrhagic pancreatitis that, although an acute pancreatitis may develop after removal of the gall-bladder as a post-operative complication, due to trauma, or to an extension of an acute gall-bladder infection, I have been unable to find a single case in my own personal files, our hospital records, or the literature as a late sequel to cholecystectomy. It is true that occasionally, after cholecystectomy, the patient suffers from attacks of epigastric pain which suggest pancreatitis, but these attacks are usually of a mild character and generally subside spontaneously. I have had one experience after cholecystectomy where re-operation became necessary because of severe epigastric pain, vomiting, slight jaundice, and a rise of temperature to 101°. Extensive adhesions were found, producing a definite kinking and a dilatation of the common bile duct, with marked induration of the entire pancreas, particularly of the head. Separation of the adhesions and straightening out of the common bile duct led to an uneventful recovery.

In addition to the cholecystectomy, I believe that the pancreas should be exposed, preferably through the gastrohepatic omentum. If this is too shrunken to give easy access, an opening in the gastrocolic omentum may be made. The peritoneum overlying the pancreas which constitutes the posterior wall of the lesser sac should be transversely incised as widely as possible, but care should be taken not to enter the substance of the gland itself. This form of decapsulation relieves the congestion and œdema and helps to restore the gland to its normal condition. Cigarette drains should be led down to this area.

My associate, Dr. Walter T. Stenson, and I have made a series of anatomical studies on the cadaver to determine, first, which is the most satisfactory approach to the pancreas, and, second, whether the pancreas has a capsule of its own in addition to the overlying peritoneum. We have found that the pancreas is by far most easily accessible through the gastrohepatic omentum, from an opening in which it can be readily exposed for its entire length. We have found further that the pancreas has no real capsule of its own, either macroscopically or microscopically. It simply lies retroperitoneally and is covered by the peritoneum, which comprises the posterior wall of the lesser sac and which is delicately adherent to the gland.

As to prognosis, the immediate operative results, barring unexpected complications, should be most satisfactory. The patients are not violently ill and the risk seems to be minimal. There appears to have been no direct mortality after operation on a straightforward case of subacute pancreatitis. The end-results also seem to be good, although the problem is too recent, the number of cases reported is still too small, and the period of observation is too short for definite conclusions to be drawn. While the possibility of a recurrence of the pancreatic disturbance after cholecystectomy and decapsulation cannot be denied, serious trouble seems unlikely. In the three cases reported above, the first patient has had no recurrence of attacks for three years and five months, and the second has been well for ten months. In the third case, cholecystectomy was not done so that no conclusion can be drawn regarding the effect of this procedure, but following only the splitting of the peritoneum over the head of the pancreas, the patient has been free from symptoms for nearly six months.

Summarizing these observations, I feel that there is sufficient evidence to warrant the belief that a subacute or mild pancreatitis, or so-called acute œdema of the pancreas, does exist as a pathological and clinical entity, independent of frank, outspoken gall-bladder disease, though it is most likely due to some primary disturbance in the biliary system. In all probability it occurs much more commonly than has hitherto been supposed. It also seems probable that this condition is a forerunner of the acute hæmorrhagic or necrotic, and possibly also of the chronic varieties. Further, the clinical picture of this form of pancreatitis is sufficiently typical for a diagnosis to be made in the majority of instances. Finally, early operative interference, usually cholecystectomy, combined with splitting of the peritoneum overlying the pancreas, and drainage of the surface of the gland, the approach being preferably through the gastrohepatic omentum, appears to be indicated, and offers a favorable immediate and ultimate prognosis.

In conclusion, I wish to acknowlege my indebtedness to all my colleagues at the Lenox Hill Hospital who have so kindly placed their clinical material at my disposal.

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DISCUSSION.—DR. OTTO C. PICKHARDT said that, as several of his cases had been mentioned by Doctor Stetten, he felt in a position to discuss several points that were of interest to him. First, the diagnosis: This is difficult and not so simple as Doctor Stetten makes it seem. As to symptoms, if the subjective ones were tabulated, half would fit under the gall-bladder and half under the duodenal ulcer caption. Specifically, the food symptoms were those of ulcer, the pain symptoms those of the gall-bladder, both in severity and type. The objective symptoms were such that they also could be caused by either a cholecystitis or an ulcer lesion. In one of the cases mentioned, the X-rays were curiously unreliable. On one examination a diagnosis of duodenal ulcer was made with the gall-bladder plates normal, while on succeeding examinations a diseased gall-bladder was diagnosed with a normal duodenum; whereas at operation, both the duodenum and the gall-bladder were found to be normal. Here, then, is a condition of which Doctor Pickhardt, for one, could not make a sure pre-operative diagnosis, but had to advise an exploration. Possibly the findings of an occasional fleeting glycosuria might be of value here. Doctor Stetten had expressed regret that in this case the gall-bladder was not removed. Now that organ was as normal as any that could be seen—thin-walled, greenish, translucent and showing absolutely no signs of inflammation. That brings up the question of the etiology of the pancreatitis; in this case it was evidently not biliary, but possibly due to an infection backward through the excretory duct of the pancreas, through the duct of Wirsung or of Santorini by the entry or reflux of intestinal juices. Anatomically, this is easily possible, as a separate opening into the duodenum or the common duct is not unusual. Certainly, the removal of a normal gall-bladder would not remedy that state of affairs. If one admits the possibility of an acute pancreatitis from causes outside the biliary system, it necessarily follows that the gall-bladder may be perfectly normal and hence its removal is not indicated. When the gall-bladder is diseased, of course, it should be removed, but should more be done? Should the pancreatic covering be incised and drained? Doctor Pickhardt thought it should. And still, when one remembers, one thinks of cases done by oneself and associates where the gall-bladder did not seem nearly acutely diseased enough to account for the symptoms and yet, after removal, the patient was apparently cured. Here, probably, the pancreas was involved, but that fact did not stand out sufficiently. Hence, a more thorough examination of the pancreas should be made in all these cases. The speaker said he believed that Doctor Stetten has made a valuable contribution to pancreatic literature.

DR. FREDERIC W. BANCROFT asked Doctor Stetten how obvious it is at operation that the pancreas is diseased. He recently saw a case with extreme epigastric pain which was diagnosed before operation as penetrating ulcer. At operation, nothing was found to account for the patient's pain. The man was a painter, but there was no evidence of lead poisoning, and a thorough study of the nervous system and blood-tests appeared to exclude

syphilis. Since hearing this paper, it occurred to the speaker that this might have been a case of subacute pancreatitis.

Dr. Ralph Colp said that he was glad to learn that the difficulty of the diagnosis of acute pancreatitis existed not alone at Mount Sinai Hospital but at other hospitals as well. He recently had had a patient who had suffered previous attacks with symptoms which sounded like those of gall-bladder disease, and at operation the gall-bladder appeared normal. It was barely possible here that the pathology may have been due to œdema of the pancreas. In some cases of acute pancreatitis glycosuria has been noted, but this finding would not be important in œdema of the pancreas since it is unaccompanied by pancreatic destruction. Doctor Colp took exception to Doctor Stetten's rationale of treatment. If the gall-bladder appears normal there is little chance of œdema of the pancreas being due to the extension of the infection along the lymphatics to the pancreas. It is more than likely that most cases of acute pancreatitis and possibly œdema of the pancreas are due to a retrojection of bile up the pancreatic duct, dependent on anatomical varieties. If this is so, then external drainage of bile is indicated. In a group of forty-three cases where the gall-bladder was examined, forty-one showed definite pathology of the gall-bladder, and in two, the gall-bladder was reported normal and was drained; stones subsequently extruded through the cholecystostomy wound. The initial attack may have been due to impacted stones.

Therefore, the speaker could not see whereby the removal of the gall-bladder alone would help the pancreatitis unless this was accompanied by common duct drainage. It is difficult to drain the choledochus with a T tube, but it would not be difficult to drain the common duct via the open cystic duct, placing the drainage down to it.

Dr. Carl Eggers said that Doctor Stetten had alluded to the duct method of invasion of the pancreas and it is probably that method which leads to the acute cases of pancreatitis. There is no certainty as to the etiology of pancreatitis. One group of writers favors the theory that an influx of bile or duodenal contents through the duct starts the process, while another group believes that pancreatitis is an infection due to lymphatic invasion from without, usually from the biliary system. Mann and Giordano, of the Mayo Clinic, have shown that reflux of bile into the duodenal duct is possible in only a small percentage of cases. It has seemed to Doctor Eggers, on the basis of personally observed cases, that it is this small group of cases, in whom the anatomical conditions are favorable, that pancreatitis occurs. Certain it is that in acute pancreatitis one nearly always finds associated gall-bladder disease. This gall-bladder disease is not acute, but either chronic cholecystitis or cholelithiasis and there is no evidence that infection as such plays a rôle. In his own cases he had taken cultures of the peritoneal and the retroperitoneal fluid, as well as of the gall-bladder, and he found no positive cultures. He believes that the entire condition is chemical rather than infectious in character. In case spread of infection from the gall-bladder

played a rôle, one would have clinical symptoms referable to the gall-bladder for some time previous to the onset of pancreatitis, but that is not the case. The patients are stricken suddenly and are at once critically ill. Something has happened, probably an influx of bile. Several of Doctor Eggers' patients had repeated attacks, one as many as eight attacks, but it is impossible to say whether they were due to gall-stones or to milder forms of pancreatitis than the attack for which operation was performed.

For the type of pancreatitis reported by Doctor Stetten, and which he calls subacute, it may be possible to assume lymphatic invasion from without as the etiological factor. It is difficult to say of how much clinical importance this condition is, and whether it can be diagnosed. If one believes that there is a close relation between gall-bladder disease and pancreatitis the treatment advanced by him, namely cholecystectomy and drainage through the cystic duct, seems a rational one. The speaker stated that in his own experience the milder forms of pancreatitis were rare. He had made it a practice in most of his gall-bladder cases to palpate the pancreas and it had usually been found in a condition which he considered normal. Even if it seemed a little larger or harder the condition was difficult to interpret, as there was no definite change. At any rate, as long as the operation was undertaken for the cure of cholecystitis or cholelithiasis, and the gall-bladder was removed, the pancreatic condition would spontaneously clear up. He had seen no case of pancreatitis develop after cholecystectomy.

DR. ALEXIS V. MOSCHCOWITZ regretted, in a measure, the new subdivision proposed by Doctor Stetten because, from long experience, he has found the entire question of pancreatitis sufficiently difficult and only after many years of study did his views finally become crystallized. In short, he divided these inflammatory diseases of the pancreas into two main groups: namely, acute and chronic. The first group is very frequently undiagnosticated and is characterized by more or less extensive areas of fat necrosis, and frequently also by hæmorrhage in and about the pancreas. Some of the cases go on to the development of cysts, abscesses and even gangrene. The second group, *i.e.*, cases of chronic pancreatitis, are usually diagnosticated in the course of operations for presumed cholecystitis, and are characterized by very firm induration in the head of the pancreas. As to the treatment, Doctor Moschcowitz was not quite certain. He is by no means convinced that the much-lauded operation of cholecystostomy is *sine qua non*. He well remembers operating on two cases of acute pancreatitis in which all that was done was an exploration of the abdomen, in order to establish the diagnosis, and an incidental appendectomy, and yet both patients made an uninterrupted recovery. On the other hand, he also remembers a case which he reported on a previous occasion. The patient was exceedingly ill and was operated on for supposed cholecystitis. There were no gall-stones, but an acute pancreatitis with hæmorrhage was found. Cholecystostomy was followed by complete recovery and the patient was ready to be discharged from the hospital with directions to continue the drainage for at least three months. On the night

before her discharge from the hospital, with a perfectly functioning cholecystostomy, the patient was again seized with violent symptoms and at re-operation an enormous, fresh, peri-pancreatic hæmorrhage was found, from which the patient succumbed. Doctor Moschcowitz did not wish to deny the existence of the symptom complex as described by Doctor Stetten, but was inclined to the belief that it is exceedingly rare.

Dr. Joshua F. Sweet called attention to the necessity of clearly distinguishing between the condition of acute pancreatitis and the condition of chronic pancreatitis. Acute pancreatitis seems to be caused by the activation of trypsinogin into trypsin, not where it normally occurs—in the lumen of the intestines—but within the tissues of the pancreas itself. This proteolytic ferment digests everything with which it comes into contact, including blood-vessel walls—therefore the hæmorrhage.

Chronic pancreatitis, in Doctor Sweet's opinion, is a lymphangitis, progressing from the lymphangitis of the bile passages. The reason for this belief is that the condition is often limited to the "triangle of pancreatic involvement," that is, to that portion of the pancreas which is derived from the persisting ventral anlage. This portion of the pancreas develops from one of two buds which grow out from the primitive intestine very close to the liver bud, or even from the lower part of the liver bud. The lymphatics of this part of the pancreas are, therefore, in very close relation with the lymphatics of the bile-ducts.

This concept of an acute œdema of the pancreas has never been clear in the matter of the origin of the excess fluid. An excess of fluid in tissue occurs as a concomitant of inflammation, and is then associated with extravasation of white and red cells; a simple œdema results from back pressure in the lymphatics.

Does Doctor Stetten conceive of this condition as an early stage of the acute disease?

Dr. Morris K. Smith said that in view of the theory of reflux of bile as a cause of pancreatitis he wished to cite a personal experience. He operated on a young woman for acute pancreatitis and drained the gall-bladder after removing some stones. The patient convalesced satisfactorily until such time as the biliary drainage had ceased, or practically so, when suddenly there developed severe pain deep in the epigastrium and back accompanied by elevation of temperature, rapid pulse and all the appearance of an attack similar to that with which she entered hospital. The sinus tract was probed with a re-establishment of biliary drainage and prompt subsidence of symptoms.

Dr. Seward Erdman said that from the observations he had made at the New York Hospital in these cases, he endorsed Doctor Stetten's statements as to the clinical entity. To the speaker's knowledge, only about three cases have been correctly diagnosed before operation, on the Second Surgical Division of the New York Hospital during the last fifteen years, as acute pancreatitis. The diagnosis of acute pancreatitis is difficult. In view of Doctor Sweet's

paper read before this Society last May, in which he claimed that no bile ever leaves the gall-bladder by the ducts, how can Doctor Sweet now state that infected bile from the gall-bladder goes to the pancreas? By a rather odd coincidence, on the day the programs announcing the subject of that evening's paper were received, a patient was admitted to the hospital presenting the essential features of this diagnosis. The patient referred to came in as an acute appendicitis; there was no rise of temperature nor increased rapidity of the pulse, but there was great abdominal pain at the onset. There was no history of previous attacks. He held himself very rigid. The one notable observation was the presence of a prominent ridge across the epigastrium which led to the inclusion of this case among the three cases of pre-operative diagnosis of pancreatitis. At operation by Doctor Garlock, the only finding was a definitely enlarged pancreas. The gall-bladder was palpated and found normal. A drain was put down to the pancreas and nothing was done to the gall-bladder; if anything had been done it would have been a cholecystostomy, for the patient was very sick and in great pain. He made a perfectly smooth convalescence. Doctor Erdman asked Doctor Stetten why he believes there is special virtue in incising the posterior peritoneum, covering the pancreas. Such incision of the peritoneum, which merely covers one aspect of the organ, cannot act to relieve tension in the pancreas.

Dr. Henry H. M. Lyle referred to a case of acute pancreatitis which he had shown before this Society fifteen years ago in which nothing was done to the gall-bladder but a portion of the head of the pancreas, being gangrenous, was removed. After a stormy convalescence the patient got well.

Dr. John Douglas said that as Doctor Eggers had stated, there are cases in which there are recurrent attacks of pain in which it is impossible to say whether the gall-bladder or the pancreas is involved. Several years ago Doctor Douglas had a patient with acute pancreatic necrosis, on whom he operated and found a large number of stones in the gall-bladder. The patient died. At autopsy a large, necrosed hæmorrhagic condition was found in the head of the pancreas. Further back there were areas where the pancreatic tissue was replaced by thick, creamy material, the result of breaking down of pancreatic tissue in previous attacks. It seemed to Doctor Douglas that the terminology "itis" indicates an inflammatory condition. Whether acute involvement of the pancreas is due to reflex of bile, or a reflex of intestinal contents into the pancreatic duct, or whether it is due to the activation of pancreatic ferments, as suggested by Doctor Sweet, it is not an inflammatory condition and it would seem, therefore, that pancreatic necrosis was by far the better term to give a right impression of the lesion present in this acute condition of the pancreas.

Doctor Stetten, in closing the discussion, replied to Doctor Bancroft's question, "How obvious is the pancreatic lesion?" that in the case he had observed it was a very typical and definite condition. The gall-bladder was

not involved grossly, but the pancreas, examined through the gastro-hepatic omentum, was found to be half again its normal size and of very firm consistency. The overlying peritoneum of the posterior wall of the lesser sac was intensely injected and œdematous, but there was no hæmorrhage, necrosis or suppuration. In answer to Doctor Colp, regarding the indication for cholecystectomy, Doctor Stetten said that he believes Doctor Colp's own statistics justify this procedure. Doctor Colp stated that in forty-three cases in which the condition of the gall-bladder had been noted, this organ was found obviously diseased in forty-one instances. Without entering too deeply into the question of etiology, Doctor Stetten thinks that these figures rather strengthen the theory that disease of the gall-bladder is usually in some way or another connected with the pancreatic involvement, and on this basis, he feels that it is safer to perform a cholecystectomy. Answering Doctor Sweet, Doctor Stetten said that he believes that the lesion is really an inflammatory condition, irrespective of whether the cause is bacterial or chemical, and that the œdema is a precursor of the more destructive lesion. Referring to Doctor Erdman's question, Doctor Stetten stated that he believes that the cystic duct region should always be drained after cholecystectomy in these cases. He also believes that, although the pancreas has no definite capsule, the overlying peritoneum of the posterior wall of the lesser sac acts as a pseudocapsule, which Doctor Stenson and he found to be delicately adherent to the pancreas. He feels that the splitting of this peritoneum acts as a form of decapsulation, which reduces the congestion of the organ, facilitates a recession of the œdema, allows drainage in the case of possible suppuration, and also probably relieves the pain by releasing the peritoneal tension.

ECTOPIC SPLEEN CAUSING INTESTINAL OBSTRUCTION

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from the surgical service of the sidenham hospital

Ectopic or wandering spleen is a comparatively rare condition, as is indicated by the fact that in five hundred splenectomies done at the Mayo Clinic [1] there were only two cases of "wandering spleen."

Case Report.—The patient in my case was a woman, seventy-three years of age, who had been in good health for the past forty years except for four attacks of pain in

Fig. 1.—Skiagraph showing the interruption in the fecal flow in the colon caused by the pressure of the wandering spleen.

the lower abdomen, constipation, and nausea without vomiting. There had been a twenty-year interval between the last attack and its predecessor. The attacks had lasted one to two weeks, with the exception of the last, which was of only ten hours' duration.

This last attack occurred in May, 1929, and since that time the patient had lost about twenty pounds in weight, partly owing to her loss of appetite, due to fear of the pain. A fluoroscopic examination with a barium meal a few days after this attack was followed by a low-grade fever of 100° to 100.5° F. at night.

For two months previously, the patient had felt a sausage-shaped mass in the lower quadrant, which at one time during the barium meal had become quite large and tender. She had refused to submit to any operative procedure and had been treated with ice

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packs by her family physician. She was admitted to the Sydenham Hospital on August 5, 1929.

On examination there was a palpable mass in the left lower quadrant in the sigmoid axis. It appeared to be sausage-shaped, was not movable, but was compressible. There were moderate abdominal tenderness and rigidity on palpation, most marked on the left side.

The X-ray examination of the colon with a barium enema showed the following:

The rectum and distal end of the sigmoid filled readily. About mid-sigmoid there was evidence of some obstruction with very definite tenderness. After a short interim the obstruction was overcome and the barium meal was seen to pass into the descending and transverse regions of the colon. During the entire fluoroscopic examination this portion of the sigmoid over an area of about three inches in length appeared extremely spastic. The film picture had the appearance of a chronic inflammatory lesion.

In view of these findings and the patient's age, a diagnosis of neoplasm of the sigmoid was made.

The laboratory tests disclosed: Urine had a faint trace of albumin, many squamous cells, many white blood cells, some clumps. Blood count on August 5: Hæmoglobin 63 per cent.; red blood cells 3,848,000; white blood cells 8,200; neutrophiles S. F. 57 per cent., B. F. 21 per cent.; S. L. 15 per cent., mononuclears 6 per cent.; basophiles 1 per cent.

On the seventh of August operation was performed under spinal anæsthesia. A left upper rectus incision revealed an ectopic, enlarged and very congested spleen surrounded by a very tense capsule. Its pedicle was twisted, and the notched anterior border of the spleen was turned downward. There were adhesions fixing the spleen to the lower ileum. The displaced spleen, weighing about 900 grams, pressed on the descending colon and the sigmoid so as to block the passage completely. The distal transverse colon and the splenic flexure were displaced downward and distended. Clamps were placed on the pedicle, the spleen separated *in situ* and then removed. There was no post-operative shock, and convalescence was smooth.

On the second day after operation, there was an arrhythmic pulse, but otherwise the patient's condition was good. The abdomen was soft and not tender; urine and gas were voided freely from the first post-operative day; there was a good bowel movement on the second day *post operationem* and a spontaneous defecation on the following day. The wound healed by primary union, and the patient was discharged from the hospital in good condition August 16.

She remained in excellent health for about two months, when she suddenly developed anuria and died.

Three blood counts were made after operation as follows:

TABLE I

Blood Counts in Author's Case

Date	Hæmo-globin percentage	Red blood cells	White blood cells	Neutrophiles		Transi-tionals	S.L.	Eosin-ophiles	Platelets
				S.F.	B.F.				
Aug. 8.....	70	4,168,000	20,000	71	12	2	14	1	..
Aug. 10....	75	4,640,000	20,000	64	14	..	12	3	..
Aug. 12....	71	4,540,000	15,000	60	11	6	..	..	408,000

The pathological report was made by Dr. A. A. Eisenberg and read as follows:

"Enlarged spleen measuring 18 by 10 by 6 centimetres and weighing 900 grams. The capsule of the spleen is considerably thickened, and the splenic artery leading to

it is also considerably thickened. On section the spleen has a nutmeg appearance, is very friable, with very distinct markings of the venous spaces.

"Histologically, the spleen shows a marked increase in the fibrous framework, the capsule is markedly thickened, the Malpighian bodies are increased in number and size in some places. In them the lymphocytes are decreased and the endothelial cells are increased proportionally. There are areas of fresh hæmorrhage present throughout. The blood spaces in the pulp are unusually dilated. Fibrosis around some Malpighian corpuscles suggests the appearance of fibro-adenoma.

"*Pathological diagnosis.*—Idiopathic splenomegaly, possibly Banti's disease?"

REVIEW OF EARLIER LITERATURE

Wandering or ectopic spleen is usually acquired and occurs more frequently in women. It is caused by traction on its suspensory ligaments and favored by enlargement of the organ with consecutive increase in its weight, and by laxity of the abdominal wall.

Torsion of the pedicle is not an uncommon complication. Intestinal obstruction due to the wandering spleen is, however, an unusual condition.

In the earlier literature there are records of five cases in which the patients died of ileus; pressure of the ectopic spleen or from its twisted pedicle was found to be the cause.

ALONZO (*Arch. d. med. espagn. y etrang.*, October, 1846) reports a case in which the spleen was found in the right iliac fossa, covered with omentum and adherent to surrounding tissues; the transverse colon was displaced by the enlarged spleen and strangulated.

BABESIU,[2] 1877, reports a case in which the patient with slight symptoms of ileus was treated with enemata, calomel and croton oil from the fourth to the thirteenth of August, 1877. The full diagnosis was made at autopsy and reads as follows: "Strangulatio ansæ jejuni per ligamentum gastro-lienale lienis migrantis dextrorsum versus tortum, subsequente thrombosi venæ et arteriæ lienalis, gangræna lienis, peritonitide et ileo." The spleen lay in the left inguinal region extending into the right side of the small pelvis. It was adherent, and the gastro-splenic ligament was twisted. A loop of jejunum was caught and compressed between this ligament and the spinal column.

In COLLINS' case,[3] 1882, an enlarged and displaced spleen pressed on the sigmoid flexure and caused strangulation.

LEDDERHOSE,[4] 1890, cited a case described by Helm and Klob in which the spleen lay along the inner surface of the left ilium, the pancreas being so displaced that it pressed the duodenum up against the vertebræ, causing gastric dilatation and subsequent gangrenous perforation.

In 1893 KÖRTE[5] demonstrated a specimen obtained at autopsy showing an ectopic spleen with a twisted pedicle. A loop of small intestine was caught and strangulated between the adhesions at the upper pole and the pedicle, causing the fatal intestinal obstruction.

REVIEW OF RECENT LITERATURE

In the more recent literature, a few cases have been reported in which a wandering spleen caused symptoms of intestinal obstruction and in which splenectomy was done with complete relief of symptoms.

O'SHEA[6] in 1915 reported two cases of wandering spleen in women; one aged forty-four, the other forty.

In the first case, there had been several attacks of severe abdominal pain and

vomiting in the past eighteen months. Three days before she came under care, she had developed a similar attack of pain and vomiting with inability to secure a satisfactory bowel movement. The abdomen was tender to pressure, and there was a large, rounded, somewhat movable and tender mass in the right iliac fossa.

At operation, this mass was found to be a large and engorged spleen, twisted on its pedicle, with "a loop of the small bowel engaged in the torsion." Splenectomy was done and the patient made a good recovery: The spleen showed chronic passive congestion. The patient was in excellent health after the operation. At the last examination, eighteen months after operation, the blood count showed red cells 4,500,000, white cells 6,900, and no abnormal cells.

In the second case reported by O'Shea, there were no symptoms of intestinal obstruction. A tumor was palpable on the left side of the pelvis. Splenectomy resulted in complete recovery.

PETRIDIS [7] in 1918 reported two cases of wandering spleen with torsion of the pedicle; one in a man twenty years of age, the other in a woman thirty-two years of age.

In the first case, before admission to the hospital, there had been four days during which no fæces were passed, and the patient had considerable pain. This condition was relieved by a laxative and hot applications. On examination a tumor was found on the right side of the abdomen. This was not recognized as the spleen until operation was done. In the second case the spleen was found to be adherent to the appendix. Both these patients were treated by splenectomy and both made good recoveries.

In 1922 PACCHINI [8] reported a case in a woman fifty-six years of age. Ten years previously she had had an attack of abdominal pain and gastric dilatation with vomiting, relieved by the passage of flatus. Shortly before admission to the hospital she had one attack of abdominal pain and vomiting, and was admitted to the hospital when a second attack developed. Meteorism was so marked that abdominal palpation could not be done satisfactorily. It was somewhat relieved by the passage of a long tube into the intestine to aid the escape of flatus following the administration of an oil purgative. Then a tumor could be palpated on the left side of the abdomen, which from its form and consistency was thought to be the spleen. At operation, this diagnosis was confirmed. The mass was of globular shape but normal in size and consistency. Splenectomy was followed by complete recovery.

BROSSMANN [9] in 1922 reported a case in a woman forty-five years of age, who was sent to the hospital with a tentative diagnosis of ileus. She had had severe epigastric pain and nausea and passed neither fæces nor flatus. There were abdominal distention and tenderness to pressure on the left side, where a tumor was palpable. At operation, this tumor was found to be the spleen on a twisted pedicle and adherent to the omentum. After freeing the adhesions and ligating the pedicle, the spleen was removed. It was enlarged and showed hæmorrhagic necrosis. The patient was in excellent health two months after operation. Three blood counts on the second, fourth and eighth days showed the lowest red cell count, 4,000,000, on the fourth day; by the eighth day it had risen to 6,000,000; the total leucocyte count diminished from 17,000 to 14,000.

In 1927 HARRIS [10] reported a case of wandering spleen causing intestinal obstruction in a man twenty-seven years of age. He had not passed fæces or flatus for about thirty-six hours prior to admission; he had vomited "some greenish fluid" once. Pain was not severe, although there were occasional "colicky attacks." The abdomen was slightly distended, and there was a large, rounded, firm mass to the left of the umbilicus. The patient stated that he had noted the presence of this "lump" for about a year, but it had caused no symptoms. An exploratory laparotomy was done. A left subumbilical paramedian incision was made and "a firm, fleshy, reddish-blue mass" found that proved to be the spleen. The pedicle had undergone torsion for one complete turn. The tail of the pancreas was contained in the pedicle. The spleen was removed without difficulty; the pedicle was ligated in several portions distal to the tail of the pancreas and the free ends of the vessels invaginated. The patient died on the ninth day following a sudden

collapse. Examination of the spleen showed a misshapen organ with a high degree of passive congestion.

Harris noted that Ledomski (*Khirurg. Mosk.*, vol. xxiv, p. 559, 1908) reported a case in 1908 in which a wandering spleen with twisted pedicle caused intestinal volvulus. In his own case, Harris believed that the twisting of the pedicle acted as the predisposing cause of the obstruction, the consequent swelling of the organ sufficing to obliterate the lumen of the bowel by pressure.

Discussion.—In my own case, I am of the opinion that elongation of the ligaments with its consequent stretching of the blood-vessels, aggravated by the torsion of the pedicle, produced congestion and enlargement of the spleen, which then pressed heavily on the intestines, as in the case noted above by Harris. I am strongly of the belief that in my case the removal of the organ was the only possible procedure, and in this opinion I find myself in agreement with others. Fowler[11] states that, in cases of wandering spleen, splenectomy is the treatment of choice and produces "slight if any change in the blood picture." Sutton[12] says that the most satisfactory treatment for wandering spleen with twisted pedicle is splenectomy.

Pool and Stillman[13] write that in cases of movable spleen beneficial results should be "confidently expected" from splenectomy and that even with torsion of the pedicle, the prognosis should be good if there is "prompt recognition that a surgical condition exists."

A definite pre-operative diagnosis of ectopic spleen causing intestinal obstruction is rarely made, as indicated by the cases already cited. The spleen under those circumstances is usually palpable as a "mass" or tumor and is often enlarged and misshapen, so that its typical outline, especially the anterior notched border, cannot be recognized. The symptoms, however, indicate the need of operation.

Removal of the spleen in adults is generally recognized as entirely compatible not only with life but also with good health and vigor. The functions of the spleen are evidently taken over by other parts of the reticuloendothelial system. Following splenectomy, there is usually some change in the blood count, which may be persistent; but there is comparatively little variation from the normal and no abnormality of the blood cells.

Fowler,[11] as noted above, believes that the blood change is slight, if any, when there is no previous disease of the spleen.

Beer[14] states that, following splenectomy, there is an increase in the blood platelets and usually in the red cells; also, a tendency of the white cells toward an increase in the lymphocytes and sometimes in the eosinophiles.

Carrol Smith[15] reports a case in which splenectomy was done for a wandering spleen simulating a uterine tumor. A month after operation, the red cell count was 5,000,000; the white cell count, 7,400.

In Sutton's[12] case of splenectomy for wandering spleen with twisted pedicle in a boy thirteen years of age, the total white cell count was high, 31,700, immediately after operation. It decreased subsequently but remained above normal (14,800) six weeks after operation. There was a steady decrease in the polymorphonuclear cells and an increase in the percentage of lymphocytes, the last count showing 59 per cent. polymorphonuclears, and 40 per cent. lymphocytes. The red cells at this time had increased to 5,100,000.

HALL [16] reports a series of blood counts in a case in which operation was performed for traumatic rupture of the spleen. The white cell count was variable for the first two and one-half months after operation; then, in the last period of observation—up to three months after operation—it showed a definite leucocytosis varying from 8,700 to 13,500, averaging 11,570, with 50 per cent. of neutrophiles and 40 per cent. of lymphocytes. From his study of the white cell count in this case, including the Arneth index, he came to the conclusion that the increase in the leucocyte count after splenectomy is due in part to the removal of some factor that restricts the production of white cells—possibly a function of the normal spleen.

LARRABEE [17] also notes that after splenectomy for ruptured spleen there is a persistent leucocytosis with a relative increase in lymphocytes and endothelial cells. These slight variations from the normal in the blood counts, however, do not appear to have an effect on general health, as all the patients in these cases are reported as in full health and vigor.

SUMMARY

1. An unusual case of ectopic spleen is reported. The organ occupied the left lower quadrant of the abdomen, in the sigmoid axis, and pressed upon the descending colon and sigmoid so as to cause intestinal obstruction. Its pedicle was twisted. Splenectomy was performed. The patient made a good recovery; but, two months later, she suddenly developed anuria and died.

2. A survey of the literature proves that such cases of wandering spleen with twisted pedicle causing intestinal obstruction are of rare occurrence.

3. The pre-operative diagnosis of the underlying cause of the intestinal obstruction in such cases is exceedingly difficult, even impossible, on account of the pathological changes occurring in the spleen, disfiguring its outline.

4. Authorities agree that splenectomy is the operation of election.

5. Following removal of the spleen, there is generally rapid improvement in the hæmatologic condition.

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INTESTINAL OBSTRUCTION

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THE problems involved in the not infrequent occurrence of intestinal obstruction and the distressingly high percentage of mortality have in the past, as even in the present, given great incentive to repeated studies and experimental work of the fundamental questions underlying the whole subject of intestinal obstruction. The illustrious work done in American laboratories of late years in experimental obstruction has been of immense value in guiding the surgeon through his prognostic as well as therapeutic ideas. In the last quarter of the nineteenth century the mortality statistics have approximated 90 per cent. Today the large clinics are reporting decided improvements over this. Van Beuren and Smith[1] record a mortality of 42 per cent. in a series of 1000 cases. In a selected series of cases W. B. Holden reports a very low mortality.[2] A better understanding of the causes responsible for death in intestinal obstruction has paved the way for rational pre-operative and post-operative care. The recognition that early diagnosis is essential for immediate surgical intervention has been an important factor in the treatment of intestinal obstruction. Surgeons today should be firm in the belief that to watch and wait is more than dangerous—that to look and act means the saving of life. Many investigators have, from time to time, advanced numerous theories for the causation of death from intestinal obstruction.

Etiology.—Among the more important considerations are: (1) The belief that the mortality in cases of intestinal obstruction was due to a nervous reflex. The sympathetic system at one time was responsible for all ailments. It is therefore not at all surprising to note that the cause of death in intestinal obstruction was credited to the autonomic system. Volvulus was thought to produce a disturbed sympathetic mechanism simulating surgical shock. Localized irritation of the vegetative system does not result in the morbid picture as is in evidence in obstructed intestinal patients. We can readily dismiss the neuro-reflex consideration.

(2) With the advent of new concepts and knowledge of the behavior of organisms, the bacterial cause was presented. The thought was expressed that the body was invaded by bacteria from the damaged bowel. This would well explain that group complicated by peritonitis. Bacteria might reach the blood-stream. Cultures, however, taken from the liver, spleen, and other organs have been invariably sterile. More recently attention and interest have been drawn to the work of Copher, Stone and Hildreth[3] and their studies of intestinal obstruction as it is related to Bacillus Welchii. Their

investigations would point to a relationship of Bacillus Welchii and intestinal obstruction. They have reported an experimental series of fourteen dogs treated with Bacillus Welchii antitoxin, in which four recovered. Their results are not impressive. We do not believe, however, they are themselves willing at this time to be conclusive in the bacterial background for intestinal obstruction. McIver, White and Lawson,[4] in a series of investigating experiments, definitely conclude that while Bacillus Welchii may be found in enormous numbers in a portion of obstructed bowel, there is some other and more important factor at work. Caution is urged in accepting the importance of Bacillus Welchii as an agent in intestinal obstruction and the use of antitoxin of Bacillus Welchii or any other serum must continue to be considered in its experimental stage.

(3) The more recent, and undoubtedly most reasonable, explanation lies in the toxin-chemical theory. There is an absorption of some toxic substance from a portion of the bowel, the route of absorption being through the vascular system—less likely through the lymphatics. Scholefield[5] has successfully demonstrated the monumental fact; namely, that when mice are injected intraperitoneally with portal blood or serum from artificially obstructed dogs, there is an invariable fatality to the mice. Systemic blood, when used, resulted in no untoward effects or obstruction manifestations. The latter may be due to the detoxifying action of liver. Fluid when taken from the lumen of obstructed bowel was of no effect when administered by mouth or injected into the bowel or intestine. The site of formation of this toxin is, of course, important, particularly to the surgeon, as to his treatment. It is quite possible, as Scholefield surmises, that the formation of the toxin within the limits of an obstructed bowel is due to a three-fold cause: bacteria, a necrosing mucosa, and increasing intra-intestinal pressure. The element of time must elapse before conditions are favorable for the toxin passing into the blood-stream.

The toxin.—The nature of this toxin has been described by Stone and his co-workers[6] as a substance resembling proteose—this intestinal substance after it has been precipitated with 95 per cent. alcohol and later specially prepared could be injected into dogs, producing the symptom complex and death, as is seen when fluid from a loop of obstructed bowel is injected. The presence of pain, vomiting, fall in blood-pressure and later collapse are in evidence. Katzenelbogen,[7] in a recent contribution, again brings to our attention the rôle that proteose-like bodies play in intestinal obstruction. These bodies, when injected either subcutaneously or otherwise, have a very pronounced stimulating action on the gastric secretion and chiefly on the secretion of free hydrochloric acid. These facts are of great importance in the acceptance of the toxin basis of fatality in intestinal obstruction, for, as will be seen later, the altered blood chemistry findings can then be well explained. This demonstration of a harmful substance in the blood from an obstructed loop of bowel is fundamental and paramount. It strongly con-

firms the validity of a toxin as being basic in the mortality of intestinal obstruction.

Chemical manifestations of blood.—Repeated studies of the chemistry of blood in intestinal-obstructed patients constantly reveal: (*a*) increased non-protein nitrogen; (*b*) fall in blood chlorides; (*c*) elevation in the carbon-dioxide combining power of the plasma. The increased non-protein nitrogen content as Haden and Orr[8] explain is due to: (1) blood plasma concentration resulting from a marked diminution in body fluids; (2) evident tissue destruction. The fall in chlorides is plausibly reasoned to be due partly to a loss of chloride as hydrochloric acid through persistent vomiting. Dragstedt[9] has advanced the thought of the toxin eliberated in obstructed patients as producing marked stimulation in gastric-pancreatic and intestinal secretions. Experimental evidence is therefore in accord with our belief of a toxic substance generated in intestinal obstruction—which toxic substance is causative of the disturbed physiology evidenced in the characteristic blood chemistry of obstructed patients.

COMPOSITION OF NORMAL BLOOD AND OF THE BLOOD IN CERTAIN PATHOLOGICAL CONDITIONS*

Special Reference to Intestinal Obstruction

	Normal	Chronic Nephrites	Diabetes	Uremia	Intestinal Obstruction
Non-protein nitrogen, Mg. per 100 cc.	25–35	35–90		90–350	35–90
Alkali reserve cc. of carbon-dioxide in 100 cc. plasma..	77–53		..		100–77
Chlorides as NaCl—per cent.	0.65	0.55–0.75	0.60	0.45–0.65	0.15–0.4

* Hawk, P. B.: Physiological Chemistry, Saunders.

SYMPTOMATOLOGY

It is unnecessary here to relate the detailed symptoms as are encountered in intestinal obstruction. A good history is essential. It should be focused towards previously complained abdominal pain. The tell-tale scar or scars of previous operations should be carefully investigated, whether or not a "clean" or drainage case. The elimination of hernia—incisional, acquired, congenital, strangulated or incarcerated. Persistent vomiting, abdominal rigidity and obstinate constipation are late signs. This triad is suggestive of trouble. The diagnosis is often difficult. A careful and painstaking history with coöperation of the laboratory and röntgenology departments will be of great assistance. As an example I can cite the case of a woman, aged seventy, who had suffered from obstinate constipation for several years, associated often with vomiting, at no time of a stercoraceous character. The patient had become extremely emaciated and weak. She finally was unable to retain food or even liquids. There was marked abdominal distension. The clinical impression was one of intestinal obstruction. Röntgen-ray study revealed nothing of importance. It did however exclude cancer, adhesions, mesenteric thrombosis, volvulus, strangulation and intussusception. The blood chemistry

showed twenty-eight millimetres non-protein nitrogen and .45 per cent. chloride. The clinical diagnosis finally reached was that of paresis of the bowel, the plexus of Meisner and Auerbach being affected. Proper therapeutic measures were instituted immediately, consisting of enemata, Rochelle salts by mouth and turpentine stupes to abdomen. The patient made an uneventful recovery and left the hospital able to retain food, and with the disappearance of any abdominal distension. The importance of a careful history, laboratory and radiographic studies is therefore evident.

Intestinal obstruction, according to Charles Mayo[10] would fall under the following category: (a) the apparent obstruction, really due to intestinal stasis; (b) obvious hernia; (c) acute obstruction from an intra-abdominal lesion; (d) post-operative obstruction. Foster[11] from a physiological viewpoint classifies the obstruction: (1) the simple obstruction, with no evidence
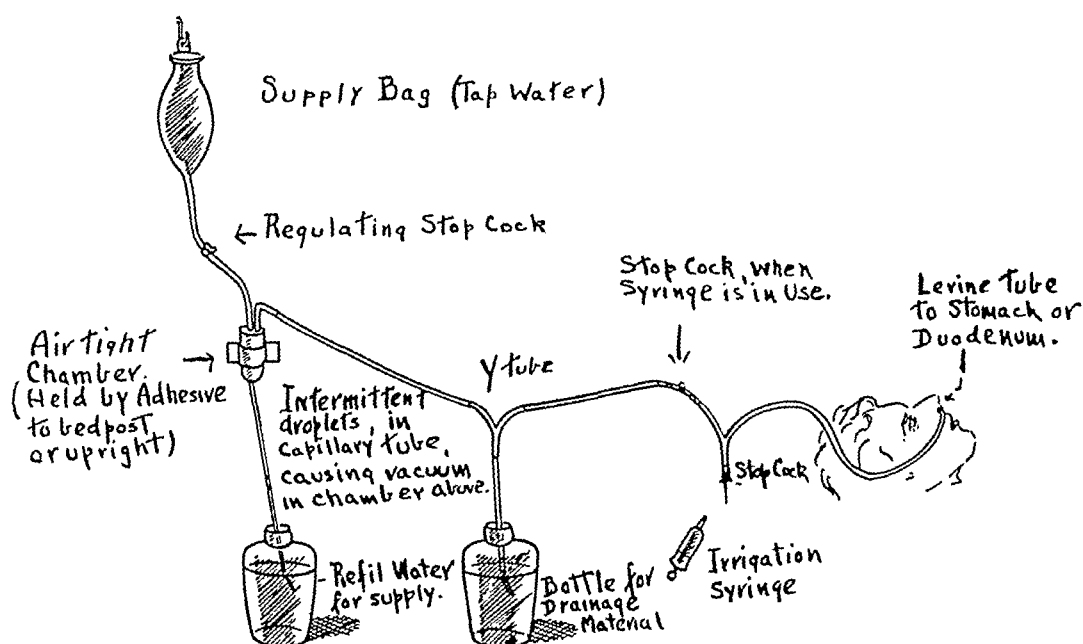
Fig. 1.—Connell suction apparatus.

of vascular derangement; (2) the acute intestinal strangulation where the vascular supply is grossly interfered with; (3) the physiological obstruction. We have used the grading of intestinal obstruction: Grade I, the simple obstruction with normal blood chemistry; Grade II, the obstruction with strangulation and a moderate change of non-protein nitrogen and chloride content of the blood; Grade III, obstruction with strangulation and presence of stercoraceous vomiting and marked increase in non-protein nitrogen content and marked diminution in chlorides of blood. It is paramount to emphasize the importance of early diagnosis. The surgeon prefers to find little or no pathology in his exploratory operation rather than to encounter too much.

Pre-operative management.—The results of pre-operative care of intestinal obstruction have been excellent. Early diagnosis is essential. Once the presence of intestinal obstruction is recognized. immediate treatment is to be instituted. The introduction of sodium chloride, by mouth, by rectum,

subcutaneously and intravenously. The amount used is chiefly governed by the type of obstruction. The normal saline solution is used intravenously, a 3 per cent. solution has been found efficacious. The intravenous infusion may be repeated during the day, chiefly being governed

Murphy BUTTON

Murphy Button
Plus Rubber Tube.
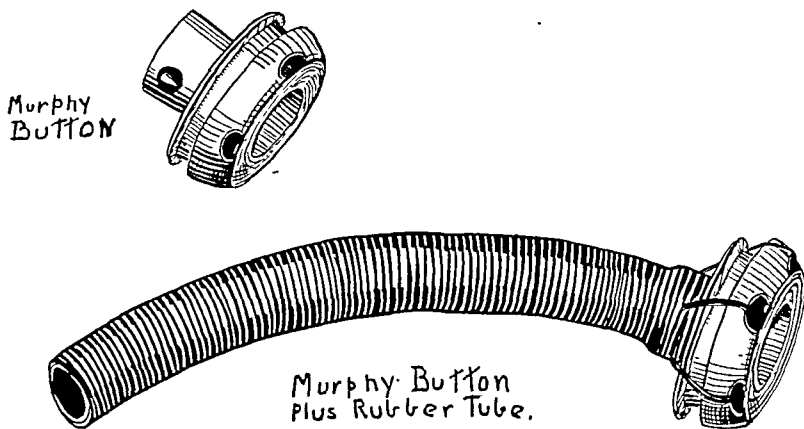
FIG. 2.

by symptoms and progress. The use of glucose intravenously and rectally is beneficial. Without subjecting the patient to any unnecessary pain or further risking the margins of safety, withdrawal of blood for chemical analysis may be done. Cathartics and food by mouth are contra-indicated.

Segment of Bowel
a) With Purse String
Suture In Place

Murphy-Sullivan
c) Tube Completed.

Murphy Button + Tube
In Place.
Purse String
b) Not Completed.
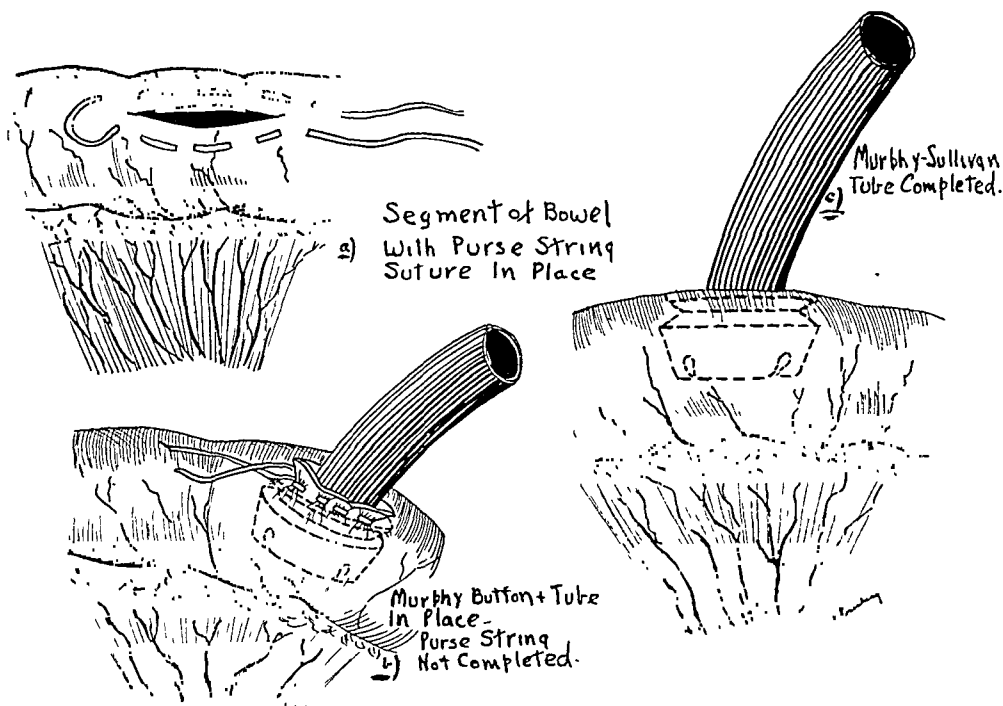
FIG. 3.

Where abdominal distension is in evidence, and the time limit can be overlooked with certainty, measures to alleviate or combat this condition can be considered. We have found the turpentine stupe, the flaxseed poultices, or common heat of benefit. The use of pituitrin or eserin is dangerous.

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·Enemata with the patient in the knee-chest position are highly beneficial, the types used frequently being the milk and molasses, olive oil, hydrogen peroxide, and barium.

Dr. P. F. McPartland, working with the Connell Suction (Fig. 1) has had excellent results with its use in obstructed patients.[12] In our pre-operative armamentarium of obstructed patients, the use of the Connell suction is valuable.

In patients presenting the diagnosis of intestinal obstruction who are poor operative risks, the use of saline intravenously, glucose and saline per-rectum, stimulatory medication, and, lastly, the introduction of the Connell suction will be life saving and greatly reduce the mortality in an otherwise fatal condition.

Surgery.—It is therefore evident that surgical interference in intestinally obstructed cases must be preceded by a careful consideration of the foregoing facts. A lengthy operation may prove too great a tax on an already rapidly diminishing margin of a patient's resistance. The spinal route in experienced hands is the anæsthesia of choice. Nitrous oxide or regional infiltration may be used. The site of incision should correspond to the more common areas of obstruction; namely, appendiceal, hepatic or sigmoid. A rapid exploration may be done to quickly determine the point and cause of the obstruction. Whether to remove or correct the cause should be tempered with caution, with the life of the patient at stake. After the storm has passed removal of the obstruction causes may be considered. A too sudden release of obstruction may cause death. In moderately mild obstruction cases specific surgery is indicated. But

Fig. 4.—Murphy Sullivan tubes in place. Abdomen closed. Points of usual obstruction. (a)—Appendical. (b)—Hepatic. (c) —Sigmoid.

unfortunately we do not often encounter the early obstructed case. They come to us when the diagnosis has been made late, where the time element has elapsed sufficiently to allow absorption of the toxin. The incision is made at one of the points above mentioned. Clear odorless fluid emerges; this would indicate early peritoneal effusion, a good omen; the gushing of sanguinous fluid would mean serious trouble ahead, especially if foul. A "knuckle" of gut forces itself out of the wound—it is this segment that is "crying" for relief. The method of treatment at this stage, which, in our hands, has yielded very gratifying results, is basically one of drainage. The senior author has used for several years the Murphy button plus an attached rubber tube. (Figs. 2, 3, 4.) This is done rapidly. The soil-

ing of the operating field is thus prevented, and a later peritonitis is thus minimized. The precautions against peritonitis are essential, for mortality in obstructed cases rises rapidly and is a real menace. Similar incisions and insertions of Murphy Button tube are advisable in other portions above the obstructed bowel. When the tubes are in place, irrigation with normal saline solution is effected. This is continued until the solution comes through the tubes clear. The patient is now given sodium chloride 3 per cent. intravenously, glucose and salines rectally. Supportive stimulation is advisable. The Connell suction may be used to advantage at this time. When the patient has been brought out of danger, when the pulse, respiration and temperature are in normal limits, and when the patient presents an operative risk, further exploratory, removal of Murphy Button tubes and causes of obstruction may be undertaken.

SUMMARY

1. In the light of recent experimental work it seems most probable that a toxic substance produced in the obstructed bowel is responsible for the grave symptoms and death.

2. The dissemination is by way of the portal blood stream.

3. Pre-operative and post-operative introduction of salines through all channels.

4. The use of the Connell suction.

5. Early diagnosis and surgery paramount.

6. Use of Murphy-Sullivan tube of great benefit.

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THE USE OF PERFRINGENS ANTITOXIN IN INTESTINAL OBSTRUCTION

AN EXPERIMENTAL STUDY*

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OF PHILADELPHIA, PA.

In 1926, Williams[1] reported favorable results from the use of bacillus Welchi (perfringens) antitoxin in patients suffering from intestinal obstruction. He reported a reduction in the operative mortality of a series of cases treated with this antitoxin to 9.3 per cent. in contrast to one of 24 per cent. in a series of cases which were not given perfringens antitoxin. Such a striking reduction immediately called this work to the attention of other surgeons. Bower and Clark[2] and others have also reported favorable results following its use in patients.

Recently, experimental evidence has been advanced which would confirm Williams' findings. Morton and Stabins[3] found that, in dogs, the development of the toxæmia following obstruction in the jeunum seemed to be delayed by the administration of the antitoxin and the mortality was lower in animals given perfringens antitoxin previous to operative relief. Copher, Stone, and Hildreth[4] utilized an isolated closed loop of the jejunum and concluded that the administration of the antitoxin prolonged the life of the animals. Unfavorable reports following the use of perfringens antitoxin in experimental obstruction have come from McIver, White, and Lawson,[5] who were unable to demonstrate any beneficial effect from the antitoxin when given to cats having jejunal obstruction and from Owings and McIntosh,[6] who studied obstruction of the jejunum in dogs. Our results, are similar to those reported by these authors.

Method. Our work was undertaken in the hope of securing additional confirmation from the experimental laboratory of the exceedingly promising results obta'ned by Williams. An attempt was made to simulate as closely as possible the usual type of intestinal obstruction encountered in the clinic. The experiments cited above have dealt without exception with high intestinal obstructon. Actually, the preponderant number of cases present obstruction at a lower level, usually the lower ileum or colon. The two types are distinct. High obstruction is characterized by excessive vomiting with resultant or concomitant depletion in blood chlorides, alteration of base and nitrogen retention. There is a very rapid lethal termination in untreated cases. Alterations in the chemistry of the blood are not conspicuous when the obstruction is in the lower bowel and dogs with this type of occlusion do not vomit. Accordingly, we chose a uniform low level for the production of obstruction; namely, six inches above the ileo-cæcal juncture. In addition to simulating closely the common type of clinical obstruction, this procedure provided an obstructed segment of bowel which afforded a favorable media for the growth of anærobic organisms, normally found in greater numbers in the more distal segments of the intestinal tract.

A simple occlusion by section and inversion of the stumps was chosen in preference to more complicated or artificial procedures such as strangulation occlusion or isolated loop. The anæsthesia for all operations was sodium amytal injected intraperitoneally. The dosage was fifty milligrams per kilo of body weight. The technic involved a section of the ileum by the cautery between clamps at the definite level noted. The stumps were then inverted by silk sutures according to the aseptic method of Kehr. Any laceration of the mesentery was repaired. In interpreting results, only those animals were considered for which no cause of death, other than toxæmia, was apparent at autopsy. The dogs that died from peritonitis or other accidents incident to the operation were excluded. It is unfortunate that autopsy protocols were not reported in some of the previous studies. Every animal in this study was autopsied shortly after death. Food and water were given the animals but they rarely ate.

Results.—A group of seven dogs served as a control. These survived for two, three, three and one-half, five, six, eight, and sixteen days respectively. The average was 6.2 days. The wide range in the duration of life, in this as well as in the other groups, will be commented on later.

Survival Period After Obstruction

Days	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Controls		●	● ●		●	●		●								●								
Normal Serum		●	●				●		●															
Intravenous Antitoxin		●	● ●	●	●	● ●																		
Enteral Antitoxin			● ●	●		●		●																●

A second control group of four animals served to test the specificity of the antitoxin under consideration. These dogs were given fifty cubic centimetre of normal horse serum intravenously at the time the obstruction was produced. The average duration of life in this series approximated very closely that of the first group, namely 5.8 days.

Seven animals were then given perfringens antitoxin (Mulford) fifty cubic centimetre intravenously, at the time of the operation, so that each animal received a dose which would neutralize 62,500 minimum lethal doses of perfringens toxin. These animals lived from two to six days or an average of 4.1 days.

Finally, the antitoxin, 62,500 minimum lethal doses, was injected directly into the obstructed loop of ileum. Six animals had an average survival period of eight days. There is included in this group, however, a remarkable animal which appeared emaciated but quite healthy twenty-four days after operation. He was killed and found to have a completely obstructed bowel. Unfortunately, no cultures were made in this dog. If this exceptional animal is omitted, the average for the group becomes 4.8 days, or approximately the same as that in which the antitoxin was given intravenously.

Comments.—The variability in the effects produced by obstruction at a given level and by a uniform technic was noteworthy throughout the experiments. The duration of life varied from two to twenty-four days. The

pathological changes were likewise inconstant. A separate series of five animals was re-operated on the fifth day, the obstruction being relieved at this time. One animal showed dilatation of the bowel for a distance of not more than twelve inches above the obstruction and very slight œdema of the intestinal wall. In another there was distention and œdema of the entire proximal segment as far as the duodenum and, in addition, purplish blotches of impending gangrene along the anti-mesenteric border. The lesions in animals observed at autopsy varied from moderate uniform distention of the obstructed segment to a dilatation four times the normal calibre and gangrenous perforation. Moreover, it was found to be impossible to predict from the appearance of the animals from day to day when death might occur or the nature of the pathology which would be encountered at postmortem. In several instances an animal was observed walking about its cage only four or five hours before its death. Pulse acceleration generally accompanied toxæmia. However, several animals lived for two or three days with pulse rates of 180 or more. Others did not at any time have rates exceeding 120. Alterations in the chemical constituents of the blood cannot be used as guides to the degree of toxicity in low obstruction as pointed out previously. Morton and Stabins used these as an index of toxicity in their animals with jejunal occlusion. Their proctocols, however, indicate that, even in high obstruction, these alterations occur late and are somewhat inconstant.

BACTERIOLOGICAL STUDIES.—During the early part of this experiment, an attempt was made to correlate the rate of proliferation of the anærobic organisms in the bowel with the development of toxæmia. The method involved refrigeration of samples of intestinal contents for twenty-four hours to promote sporulation, heating to 80° for ten minutes to destroy all vegetative organisms and inoculation into litmus milk. Imperfect, but satisfactory, anærobiasis was produced by keeping the media at 90° for thirty minutes and overlaying the cultures with paraffin oil. After forty-eight to ninety-six hours of incubation, the presence in the culture of anærobic, sporeforming, gas-producing organisms of the perfringens group was determined by the odor of butyric acid and the characteristic stormy fermentation of the milk with shredding of the coagulum and gas bubbles. In twenty-two animals cultured at the time and at the site of obstruction, eleven showed positive growth of organisms of the perfringens group.

A series of five dogs, not included in the previous summary of results, was re-operated on the fifth day. From the obstructed segments of these animals, material was obtained for a rough quantitative measurement of the degree of proliferation of the organisms after obstruction. This was done by the inoculation into culture media of varying dilutions of the intestinal contents. Growth was never found in dilutions higher than one to ten at the time of production of the obstruction. All four animals from which cultures were obtained on the fifth day showed marked proliferation of organisms in the obstructed bowel. Two showed growth in dilutions of 1 to 1000 and two

others in 1 to 10,000 dilution. Post-mortem cultures were not considered since agonal changes render such evidence unreliable.

CONCLUSIONS.—Throughout this study we have been impressed with the need for extreme caution in drawing definite conclusions. Ample evidence of the extreme variations encountered has been presented. It appears that the anærobic, sporulating, gas-forming organisms of the perfringens group are frequent inhabitants of the terminal ileum of the dog. Moreover, they proliferate in the lumen of the bowel following obstruction. Nevertheless, the use of the antitoxin both intravenously and enterally has not provided us with any evidence that it exerts a deterrent influence upon toxæmia or prolongs life following the production of low intestinal obstruction closely simulating that encountered by the surgeon. It may well be that giving the antitoxin, as we did, in a single dose at the time the obstruction was produced, did not render it available to the organism at the time it was most needed. Repeated administration might conceivably exert a more favorable influence, but Owings and McIntosh could not confirm this. Furthermore, a variation in the strain of the organisms concerned may account for the different results obtained by Williams.

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[2] Bower, J. O., and Clark, J. H.: Am. J. Med Sci., vol. clxxvi, p. 97, 1928.
[3] Morton, J. J., and Stabins, S. J.: Arch. Surg., vol. xvii, p. 860, 1928.
[4] Copher, G. H., Stone, C. S., and Hildreth, H. R.: Annals of Surgery, vol. lxxxix, p. 641, 1929.
[5] McIver, M. A., White, J. C., and Lawson, G. M.: Annals of Surgery, vol. lxxxix, p. 647, 1929.
[6] Owings, J. C., and McIntosh, C. A.: Arch. Surg., vol. xviii, p. 2237, 1929.

posterior vesical neck obstruction; and, finally, a discussion of the different types.

Anatomically, there are two different glandular groups situated at the vesical neck in the mid-line, posteriorly; first, the subcervical glands of Albarran; and, secondly, the posterior commissural glands of true prostatic tissue. Examination of a histological section made in this region from normal tissue shows the subcervical glands situated in a loose supporting tissue under the transitional epithelium. The posterior commissural glands are under the subcervical glands but separated from them by a thick layer of muscle tissue. (Fig. 1.) This muscle tissue is part of the trigonal muscle which will be referred to later.

Symptomatology.—The symptoms in cases of posterior vesical neck obstruction are similar to those due to prostatic hypertrophy. A list of the genito-urinary symptoms and the number of patients having these symptoms in this series is given in Table I. When the disease was of long duration, many of the patients gave evidence of general health impairment from the frequent and urgent desire to urinate and from difficulty and straining on urination.

TABLE I

Symptoms

Frequency	50	Difficult urination	7
Nocturia	50	Pains in penis	6
Burning on urination	15	Incontinence	4
Urgency	12	Retention complete	3
Painful bladder	8	Retention intermittent	3
Dribbling	8	Impotence	2
Hematuria			1

The duration of the disease in this series of cases is given in Table II.

TABLE II

Duration of Disease

5 weeks	1	5 years	6
4 months	4	6 years	3
6 months to 1 year	12	10 years	7
1 to 2 years	6	17 years	1
2 to 3 years	10		

The cystoscopic examination, in addition to showing definite posterior vesical neck elevation, frequently showed variant degrees of lateral lobe enlargement. There were but nine cases in which there was no change in the lateral vesical neck appearance. Trabeculation of the bladder was frequently seen, especially in those cases in which the duration of the disease was over a long period of time.

After removal of the posterior vesical neck obstruction, the lateral lobe enlargement soon subsided. This would indicate that the lateral bulging was due to œdema from the posterior vesical neck obstruction, rather than actual hypertrophy.

The cystoscopic appearance of the vesical neck is tabulated in Table III.

TABLE III

Vesical Neck Appearance

1. Median bar enlargement....................... ..... 9 cases
2. Median and lateral enlargement.................... 38 cases
3. No record .... 3 cases

The accompanying Table IV shows the ages of the patients in this series.

TABLE IV

Ages

20 to 30	1	50 to 60	11
30 to 40	1	60 to 70	16
40 to 50	8	70 to 80	14

A review of the histological sections made from fifty cases with posterior vesical neck obstruction presents tissue variations which can be divided into four different groups.

The first group of sections consists of atrophic, sclerotic and granulation tissue with no evidence of hypertrophied tissues. (Fig. 2.) The second

FIG. 3.—Microphotograph showing hypertrophied subcervical glands under the transitional epithelium.
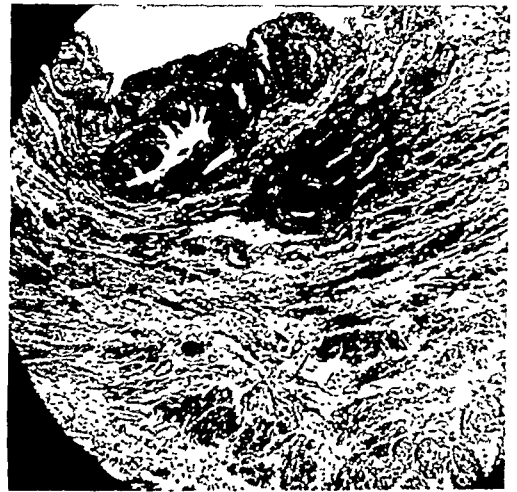
FIG. 4.—Microphotograph of hypertrophied muscle tissue obstructing the posterior vesical neck.

group consists of hypertrophied glandular tissue which is made up of varying sized acini scattered in a loose supporting tissue. The acini are lined with cuboidal and low columnar epithelium with some degree of intra-acinar papillary proliferation of these cells. (Fig. 3.) The third group consists entirely of muscle tissue, with no evidence of glandular hypertrophy. (Fig. 4.) Finally, the fourth group is made up of hypertrophied muscle tissue penetrated from below by hypertrophied glandular tissue. The glandular acini in this group appear similar to those in Group 2. (Fig. 5.)

Discussion.—While there is a definite difference in the histological findings in all four groups, the findings in Group 1 are undoubtedly the result of infection. The difference in Groups 2, 3, and 4 is apparently explainable on an anatomical basis.

Before discussing the latter groups, it is essential to review the relation of the trigonal muscle to the internal sphincter of the bladder as described by Young.[2] He frequently observed that during cystoscopy, if a violent desire to urinate came on, the trigone would contract greatly and the prostatic orifice would open widely, the posterior portion being apparently drawn backward by the muscle fibres which run from the trigone down into the posterior urethra and which were seen to contract violently. He feels that the opening of the internal sphincter during urination will have to be viewed as the result of the contraction of the powerful trigonal muscle which passes in the form of an arc through a weaker muscle of circular shape and pulls it down when it contracts. (Fig. 6.)

If one accepts this explanation of Young's, it will undoubtedly become apparent that hypertrophy of posterior commissural tissue would impair the action of the trigonal muscle. If this glandular tissue is sufficiently hyper-
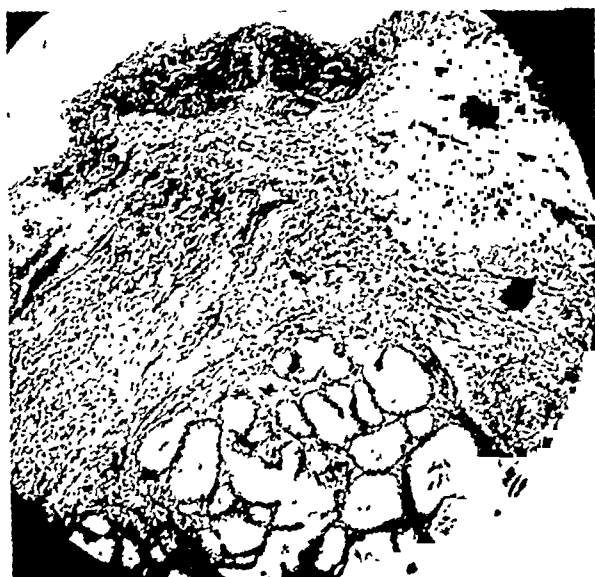
FIG. 5.—Microphotograph of hypertrophied muscle tissue penetrated by hypertrophied posterior commissural glands.

FIG. 7.—Microphotograph of adeno carcinoma of subcervical gland origin.

trophied over a long enough period of time, the trigonal muscle will have to put forth greater effort to push against this mass. The result of this increased effort on the part of the muscle causes it to hypertrophy. This muscle hypertrophy eventually becomes so great that it is the actual obstructing factor rather than the hypertrophied commissural tissue.

The foregoing evidence of Young's, given in connection with the microscopical findings in this series of cases, indicates that the hypertrophied muscle tissue seen in Group 3 is the result of overworked muscle on account of hypertrophied posterior commissural tissue.

From the histological findings in Group 4. it seems that the commissural glands in some cases hypertrophy to the degree of penetration through the hypertrophied trigonal muscle. If a patient with this type of tissue findings had presented himself for earlier treatment. the tissues removed would undoubtedly have been classified under Group 3.

The second group presents an entirely different histological picture. There is no evidence of hypertrophied muscle and the glandular tissue is situated under the transitional epithelium. We know that in the normal posterior neck, Albarran glands are in the subcutaneous tissue, and above the trigonal muscle. If these glands hypertrophy they grow out in the subcutaneous tissue, and on account of their location, have no effect upon the action of the trigonal muscle. Since in this group the later findings are evident, it is apparent that they illustrate obstruction from hypertrophy of the Albarran or subcervical group of glands.

In this series of cases studied there were three in which the obstructing tissues were adeno-carcinoma. Since there are two glandular groups at the vesical neck which may undergo benign hypertrophy, it is natural to assume that either of these groups may undergo carcinomatous changes. The lawless, penetrating manner in which malignancy grows makes it difficult in most cases to be sure of the point of origin. There was but one case in
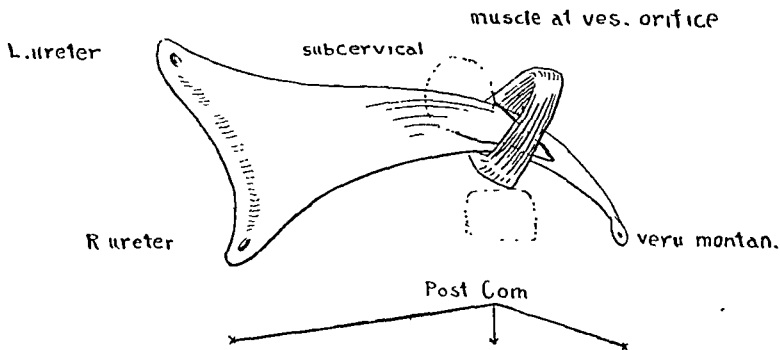
Fig. 6.—Modification of Young's diagram illustrating the relation of hypertrophied subcervical glands, and posterior commissural glands to the trigonal muscle.

which the carcinoma was found growing under the transitional epithelium with a histological appearance unlike those commonly seen in true prostatic glandular carcinoma. In this case the obstructing tissue was made up almost entirely of epithelial cells. These were very irregular in form and arrangement. There was very little stroma. The location and difference in appearance from the usual form of adeno-carcinoma of the prostatic glands would make one feel that it illustrates carcinomatous changes in subcervical glands. (Fig. 7.)

The following Table V, shows the pathological findings in this series of cases.

TABLE V

Pathological Findings

1. Inflammatory obstruction.......................... 2 cases
2. Hypertrophied muscle............................. 26 cases
3. Hypertrophied muscle and gland.................... 4 cases
4. Hypertrophied gland (*no* muscle hypertrophy)........ 15 cases
5. Adeno-carcinoma................................. 3 cases

Conclusions.—This series of fifty cases of posterior vesical neck obstruction shows, first, that the symptomatology is similar to the symptomatology in diffuse prostatic hypertrophy; second, that the obstruction may be due to either inflammatory tissue, hypertrophy of subcervical glands or posterior commissural glands; and, finally, the subcervical glands as well as the posterior commissural glands may undergo carcinomatous change.

I am indebted to Dr. Alexander Randall for permission to include many of his cases in this study.

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TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD MARCH 3RD, 1930

The President, DR. GEORGE P. MULLER, in the Chair

CALVIN M. SMYTH, JR., M.D., Recorder

OSTEOPERIOSTEAL BONE GRAFTS

DR. GEORGE M. DORRANCE read a paper with the above title for which see page 161.

DR. GEORGE WAGONER said that, since 1926, when he and Doctor Dorrance had done similar experimental work, he has had occasion to use the osteoperiosteal bone graft clinically. Several of his cases resulted in partial failure. The failures were due to the faulty preparation of the graft, there being areas in which bone chips were not adherent to the periostem. This was invariably found to be the case at time of re-operation, and, in Doctor Wagoner's opinion, explains the failures.

DR. ROBERT IVY said that his experience with bone grafts has been solely with the lower jaw and he has used the osteoperiosteal method and also the thick graft from the crest of the ilium. He feels that the osteoperiosteal graft is more useful in small defects on account of its simplicity. In a fairly long gap of two or three inches, the iliac graft is preferred, chiefly because it fills out the external deformity more satisfactorily. He agrees with Doctor Dorrance about the importance of fixation and immobilization in these cases.

DR. ASTLEY P. C. ASHHURST said that he thought that the first patient would have had a far better result with an ordinary excision of the knee-joint. He would have obtained his result in about eight weeks, although it would have been necessary to wear a brace for some time longer. The shortening accompanying this operation of excision is also an advantage, if the patient is to walk with a stiff knee, as it allows the heel to clear the ground in walking. In certain other locations, as in the shoulder, where the articular surfaces are smaller, the osteoperiosteal graft or some other extra-articular method of fixation should prove very valuable.

DR. GEORGE M. DORRANCE rejoined that he usually used excision, but that this man already had a short leg, and he wished also to avoid entering the joint and lighting up the old infection. He was sure that he has had better results with osteoperiosteal grafts than with full thickness grafts. It is a very simple operation, whereas putting a full thickness of graft in under the jaw is a formidable procedure. The last patient he operated upon

had had all the teeth removed, and it was a very simple procedure. That is what he is trying to bring out. The one patient shown surely proves that osteoperiosteal in the knees can be done.

WELCH BACILLUS ANTITOXIN IN INTESTINAL OBSTRUCTION

Dr. John P. North (by invitation) read a paper entitled, "The Use of Welch Bacillus Antitoxin in Intestinal Obstruction," for which see page 277.

Dr. Eldredge L. Eliason said about one year ago Doctor North and he investigated the mortality of acute intestinal obstruction in three hospitals. There was found to be the same as the average reported mortality of the country, approximately 30 per cent. There is a statement to the effect that in this country the mortality is actually nearly 60 per cent. C. Jeff Miller last year reported 343 cases taken from three hospitals in the South. He makes a statement that the mortality was between 60 and 65 per cent. rather than 35 and 40 per cent. This shows that there is still a very high mortality despite the fact that it is generally accepted today that dehydration and loss of chlorides on the one hand and toxemia on the other are the important factors. Replacement of chlorides by the administration of hypertonic salt solution and the relief of dehydration by large quantities of glucose have been extensively practiced for the last few years. The toxemia is another question. Much experimental work has been done and when William's report came they thought to attempt to confirm it. Doctor North had been unable to do this. It may be that the toxemia in dogs and human beings is not quite the same. Certain workers claim that dehydration and loss of chlorides in their dogs were responsible for their death and that they could find no evidence showing that toxemia had anything to do with it. So far, it has been impossible to attribute the cause of death in intestinal obstruction to any single factor and doubtless there is still much to be learned before definite conclusions can be drawn.

THE CONTRACTILE FUNCTION OF THE GALL-BLADDER

Dr. Isador S. Ravdin read a paper with the above title.

Dr. John H. Jopson remarked that this paper might better be discussed by a surgical physiologist rather than a clinical surgeon. The view that nothing which enters the gall-bladder through the cystic duct comes out by that route has been abandoned by practically all of its former advocates with the exception of Sweet and Halpert. They, apparently, have been left to hold the fort alone. From a purely philosophical standpoint, it seems incredible that nature would tolerate such an imperfect and complicated mechanism, designed for complete absorption of all bile entering it. Murphy and Higgins have demonstrated that, in animals in which experimental cholecystitis had been produced, the contractile function of the gall-bladder is restored when the cholecystitis clears up. Röntgenographic studies made after recovery showed normal behavior of the gall-bladder after the fat meal.

PERITONEAL ADHESIONS

DR. JAMES T. LACEY (by invitation) read a paper entitled, "The Use of Amniotic Fluid in the Prevention of Peritoneal Adhesions," for which see page 281.

DR. DAMON B. PFEIFFER said, that he agreed with the proposition that when two peritoneal surfaces were brought in contact with each other and the endothelium survived, the adhesion was temporary, but if granulating surfaces were allowed to come in contact with each other the adhesions formed were permanent. In spite of the great variety of substances which have been used for the prevention of adhesions, nothing has changed their picture.

INTRAPERITONEAL PRESSURE

DR. RICHARD H. OVERHOLD (by invitation) read a paper entitled, "Observations on Intraperitoneal Pressure."

VESICAL NECK OBSTRUCTION

DR. ALBERT E. BOTHE read a paper entitled, "Pathological Study of Posterior Vesical Neck Obstruction," for which see page 300.

STATED MEETING HELD APRIL 7, 1930

RECONSTRUCTION OF AN ARM IN BRACHIAL PLEXUS INJURY

DR. BENJAMIN F. BUZBY reported the case of a man, aged forty-four, who, while at work on December 19, 1928, was struck by a falling plank and knocked down and then fell fifteen feet. He was admitted at once to the General Surgical Service of Cooper Hospital, Camden, N. J., wildly delirious. When admitted there was evident a laceration, four inches long, extending upward from the right eye-brow and a fracture of the right acromion shown by X-ray to be one of a simple transverse type. He had a marked concussion of the brain but an X-ray of his skull was negative. His scalp wound was cleansed surgically under an anæsthetic, his skull was inspected and no fracture discovered and the wound was sutured loosely and rubber tissue drainage inserted.

His previous medical history was negative.

Two days after admission he became rational and complained of numbness in his right upper extremity but as this was dressed at his side at the time for his fractured acromion no great attention was paid to it. Throughout the day a severe cellulitis of his face, neck and scalp became apparent, with a temperature range of 100.6° F. to 103° F. His scalp wound was opened at once and December 24, 1928, counterdrainage was established. The scalp was further drained on January 4, 1929, and again on January 24, 1929. During this period the man was very sick. His scalp wounds were entirely covered with dry crusts on February 6, 1929.

When the dressings were removed from his shoulder January 28, 1929, it was found that the man had no useful function in his right upper extremity. A neurological consultant at this time gave the opinion that the man had suffered damage to his cervical nerve root.

He was discharged from the hospital to the Out-Patient Neurological Service February 9, 1929, where he was found to have reactions of

degeneration in many muscles of his right arm. He was treated in the Physiotherapy Department by galvanism and massage. An X-ray of his cervical spine April 2, 1929, showed a crushed fracture of the body of the sixth cervical vertebra with an old fracture of the fifth cervical spinous process.

He was referred to the Orthopædic Service for reconstruction of his arm, if possible, on June 4, 1929. It was found at this time that the man had complete and total paralysis with advanced atrophy of all muscles supplied by the fifth and sixth cervical roots of the brachial plexus, e.g., supra and infraspinatus, subscapularis, teres major and minor, levator anguli scapulæ, rhomboideus major and minor, deltoid, biceps, brachialis anticus, brachioradialis, supinator brevis, pronator radii teres, flexor carpi radialis and palmaris longus.

The serratus magnus also was involved as evidenced by the winged scapula, showing that the damage had been done to the fifth and sixth roots close up to or in the vertebral foramina before the branches came off from these roots to help form, with a branch from the seventh cervical root, the long thoracic nerve.

The whole arm hung limp at the side with no power above the elbow except the triceps, and the humeral head was depressed at least one and one-quarter inch from the acromion. There was no power to externally or internally rotate the humerus except by means of the pectorals and latissimus dorsi. There was no power to abduct the shoulder, flex the elbow or supinate the forearm. Sensation was disturbed but not abolished anywhere. His neck motions were full and free. He had power to shrug his shoulder by means of the trapezius.

It was felt that since his injury to the brachial plexus was so centrally located, function for minor use was better than none at all, so accordingly, June 13, 1929, an arthrodesis of his right shoulder was done. The bones were found very soft and atrophic. After destroying the articulating surface of the humeral head, glenoid, and under surface of the acromion, the head was suspended and fastened to the acromion by an encircling suture of kangaroo tendon. The arm was put in plaster of Paris in 60° of abduction and 45° of external rotation and kept there until August 1, 1929, when the case was changed. The new one was kept on until September 17, 1929. His post-operative course was uneventful. When the case was finally removed his shoulder was in fair position and stiff but there was no bony union. He had power through the trapezius to actively abduct the arm 30°.

Even though he had no power in the supinator longus, the muscle usually used when transplanted up the humerus to act as a flexor of the elbow, it was felt that it was worth a trial to transplant the remaining extensor muscle group attached to the external humeral condyle higher up the humerus and thus make these muscles do double duty, as it were—elbow flexion and wrist extension. This was done October 9, 1929, by separating subperiosteally the muscle origins from the external condyle and fastening them subperiosteally one and one-half inch up the outer side of the humeral shaft by means of kangaroo tendon passed through drill holes in the shaft. The arm was then fixed in flexion 20° above a right angle in an internal angular plaster splint until December 6, 1929, but massage and guided active motion were begun November 1, 1929. When his splint was finally removed, the active motion of his elbow was from 100° to 60° and he could actively abduct his shoulder 70° from his side even though the shoulder arthrodesis did not show bony union.

At present he is able to fully flex his elbow with his shoulder abducted and easily gets his hand to his mouth. In so doing the flexors of his wrist must contract against the pull of the extensors to fix the wrist so that the extensor insertions may act as origins. By so doing his hand goes into radial deviation of 20°.

As measured now his active movements are: abduction of the whole shoulder girdle, 60°; flexion of elbow to 40°; extension of elbow to 160°; and external rotation 25°.

The patient is anxious to get more external rotation of the shoulder so it is proposed soon to try and give him complete bony ankylosis of his shoulder in a more advantageous amount of external rotation.

Neurological surgeons may say that suture of the divided roots should have been attempted first, since no serious irreparable damage has been done to the muscles supplied by the torn fifth and sixth cervical roots that still could be done, if feasible, and the man's permanent disability would be then only the fibrous ankylosis of the shoulder, which exists often enough as the result of disease or injury in patients now leading active, useful lives.

TRAUMATIC BRACHIAL PLEXUS PARALYSIS

DR. THOMAS SHALLOW read a paper with the above title for which see page 182.

THE CAUSE AND ELIMINATION OF REACTIONS AFTER INTRAVENOUS INFUSIONS

DR. LEE A. RADEMAKER read, by invitation, a paper with the above title for which see page 195.

GASTRIC ULCER

DR. EDWARD WATTS SAUNDERS, of New York City, read, by invitation, a paper entitled, "A Bacteriological and Clinical Study of Gastric Ulcer," for which see page 222.

DR. J. EDWIN SWEET, of New York City, said that Doctor Saunders did not start this work with the view of finding the cause of peptic ulcer. Sometimes it is most useful to try to solve some peculiar feature of a problem, rather than to tackle the whole thing. Doctor Saunders started from two clinical facts; ulcer is a human disease, it is a chronic disease. Just at that time Doctor Lambert and Doctor Weeks were working in the laboratory on the problem of lung abscess—another human disease, another chronic disease. They were able to show in sections a ring of spirochetes advancing into the lung tissue ahead of the pus producers, apparently the reason for their chronicity. So Doctor Saunders tried the same technic—Levadity staining of properly fixed material from ulcers. He did not find spirochetes, but did find what seemed to be longer and shorter chains of streptococci.

He was then particularly fortunate in having the advice of Doctor Torrey and Doctor Kahn, of the Department of Public Health, who suggested Humtoon's medium or hormone agar. The results of this work he has shown in this paper. Especially noteworthy is the fact that of nineteen cultural attempts, ten showed the same organism in pure culture; four more showed the addition of a yeast; the rest, different casual contaminations. One would

have expected to find the entire flora of the mouth in an ulcer of the stomach.

Doctor Saunders finds no relationship between these organisms and the organisms of the so-called foci of infection; the theory of the focus of infection in ulcer is very persistent even though it would not appear from the literature that the pursuit of this theory has led to any very remarkable clinical results.

Doctor Saunders, being a surgeon, would have been justified in throwing up his hands in holy horror when he found his work heading into the abstruse problem of modern bacteriology—mutation. It seems that herein may lie an explanation for the most remarkable facts concerning ulcer; the relation of ulcer to body type; the seasonal occurrence, or recurrence; the strict limitation to the pyloric area; the explanation of the results of surgery.

Perhaps all believe in the hydrochloric theory of ulcer. It has, however, never satisfied the speaker; the ejected stream, impinging on the duodenal wall sounds good for the post-pyloric location, but does not seem to explain the pre-pyloric location. Nor has anyone offered any evidence that more acid squirts harder in November than in July.

It seems a far more likely hypothesis, and one in closer conformity to the facts, to assume that the disturbance is of the regurgitation of bile, and the effects of bile or some contained factor in the bile, upon the growth and virulence of the organism.

If Doctor Saunders' findings are accepted, it must be assumed that this organism grows only in a medium of the right degree of acidity; therefore, in the body it can grow only in the skin, the mouth, the stomach, and in the stomach it finds the correct pH around the pylorus. But a further factor is needed to explain the seasonal peculiarity of ulcer and its adherence to the asthenic type. A working hypothesis is that this second factor is the bile and perhaps some particular factor in the bile which reacts to seasonal influences.

Possibly the situation is this: in the asthenic type the duodenum is so kinked that bile, with or without this supposititious second factor, does not get to the pyloric region at all.

Rest in bed cures by relieving this kink. Gastroenterostomy cures by permitting access of bile into the stomach, whence it flows out, through the pylorus, over the ulcer. The only sterile cultures in Doctor Saunders' work have been in cases in which a gastroenterostomy was present. Resection cures by removing that area where this organism can grow; it savors somewhat of the method of curing a bunion by amputation through the mid-thigh—doubtless effective, but somewhat strenuous. Pyloroplasty does not help because the bile factor misses the ulcer area entirely.

Ulcers do occur in the plethoric type but how often does this happen without concomitant gall-bladder disease? If the biliary tract is diseased, then this supposititious factor in the bile may be lacking.

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CHRONIC ARTHRITIS SHOWING IMPROVEMENT FOLLOWING LUMBAR SYMPATHECTOMY

DR. CHARLES H. FRAZIER remarked that there are certain forms of arthritis, call them what you will, rheumatoid arthritis or arthritis deformans in which the patients often suffer from cold, clammy hands and feet. There are areas of pallor and cyanosis of the extremities, the tissues are puffy and often the surface is covered with a film of moisture. One might with propriety interpret these as signs of vasoconstriction; certainly there is a vascular disturbance involving the arterioles and capillaries. It is well known that there are certain forms of arthritis that are of neurogenic origin, as, for example, in Charcot's disease and syringomyelia.

Surgeons have been in the habit of speaking of these chronic forms of arthritis mostly from the infective point of view. The question now comes up, especially in view of the observations which have been made following gangliectomy, whether some of these forms of arthritis may not be due to imperfect nutrition, as the result of vasospasm.

So far as the speaker knows, the first observation as to the effect of sympathectomy was made by Rowntree and Adson (*Transactions Assoc. Amer. Physicians*, vol. xi: v, p. 221, 1929), and the results of their operation were so striking that Doctor Frazier ventured to apply this treatment to a case which was brought to his attention from the Medical Service of the University Hospital.

As a result of this observation Rowntree and Adson state that in certain types of arthritis the sympathetic nervous system of the extremities is hyperactive, producing marked vasomotor disturbance and profuse sweating, possibly contributing to the spasm and atrophy of the muscles with the resultant deformity. The clinical picture is characterized by coldness of the extremities, marked sweating, trophic changes of the muscles, skin and nails, tender, painful, and swollen joints. All these abnormal manifestations disappeared on release of the extremities from sympathetic control.

Certainly in times past we have been in the habit of expecting temporary relief at least from such measures as might increase the circulation and temperature of the joint, more particularly hot applications, physiotherapy, baking, diathemy.

REPORT OF A CASE.—W. P., aged twenty-five years (File No. 17921), was referred to the Neurosurgical Service of the University Hospital from the Medical Department October 29, 1929.

History.—The first attack of joint pain and swelling was in 1923, lasting three months and affecting many joints. A second attack occurred in February, 1926, which lasted until May, 1926, and a third attack began in December, 1926, the latter, however, of less severity than the two previous attacks.

May 18, 1927, to June 26, 1927, the patient was studied on the Medical Service of the University Hospital with the following findings: small buried tonsils; congenital deformity of right hand and chest; evidence of arthritis in right wrist, right elbow and both ankles. X-ray showed abscess of upper molar tooth, left wrist and ankles showed orthopædic changes.

Treatment.—Tonsillectomy and extraction of teeth.

Readmitted October 16, 1929. In the interim patient has had several similar attacks. In September, 1929, the bottom of his right foot became painful and slightly swollen, great toes of both feet began to swell and cause pain; the joints were neither hot or reddened in this attack. Pain next appeared in sacroiliac region.

Operations.—December 28, 1929: Left lumbar ganglionectomy L. 2, 3 and 4; January 2, 1930: paravertebral injection of the thoracic ganglion; January 27, 1930: right lumbar ganglionectomy, L. 2, 3 and 4.

The effect of the operations has been more than gratifying. The freedom with which the patient moves now is very much greater than before. Of course, certain structural changes had already prevented perfect freedom of motion in his knee-joints but those who observed him before the operation and afterwards, called attention especially to the greater freedom with which he walks, the erect station of the trunk which heretofore had been bent forward.

This case. Doctor Frazier thought, was an excellent one for demonstration because the process in the left upper extremity, especially the wrist-joint, had already reached the terminal stage; that is, there was complete ankylosis of the wrist-joint. The process in the lower extremities, as in the knees and ankles, was not nearly so far advanced so that here we have an opportunity to demonstrate whether or not the sympathectomy may arrest the process, whatever it may be, in these forms of chronic arthritis.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

STATED MEETING HELD APRIL 9, 1930

The Vice-President, Dr. John Douglas, in the Chair

CONSECUTIVE PERFORATIONS OF STOMACH AND OF DUODENUM

Dr. William F. Cunningham presented a man who, when thirty-six years of age, was admitted to the First Surgical Division of Bellevue Hospital, April 16, 1929. Seven and one-half hours prior to admission he suddenly developed a sharp pain in the epigastrium, which gradually spread over the entire abdomen. He vomited once a short time before admission. The abdomen presented signs of generalized peritoneal irritation. Temperature 101, pulse 90, white blood cells 15,000 with 91 per cent. polymorphonuclears. Urine contained a very faint trace of albumin. The man had suffered indefinite gastric symptoms for three weeks previously and had indulged freely in alcohol for relief. An immediate operation was performed and a perforation three millimetres in diameter on the anterior wall of the stomach close to the antrum was found, actively emitting brownish fluid. It was surrounded by a wide, indurated area. The perforation was closed with two purse string sutures. A culture taken from the peritoneal fluid was reported as sterile. With the exception of an acute bronchitis he made an uneventful recovery and was discharged from the hospital seventeen days after operation.

Seven months later, November 18, 1929, he was readmitted about four hours after recurrence of sudden, severe, epigastric pain following one week of post-prandial discomfort and constipation. The pain had spread over the entire right abdomen, which, on admission, again presented the signs of generalized peritoneal irritation. Temperature 100, pulse 100, white blood cells 10,200 with 88 per cent. polymorphonuclears. Urine negative.

At operation a four-millimetre perforation was found on the anterior wall of the first portion of the duodenum. At the time of operation it was sealed off by the liver. There was present a large amount of turbid, whitish fluid in the peritoneal cavity, the intestines were injected and fibrin was present. There was a large collection of fluid between the liver and the diaphragm. The perforation was closed by a purse string suture of chromic gut. There was no peritoneal evidence of the previous gastric perforation. Culture of peritoneal fluid showed B. Coli. Temperature rose to 103 within the first twenty-four hours and gradually subsided to normal on the fifth day.

December 11 (twenty-three days post-operative) a gastro-intestinal series was made and showed no evidence of any gastric or duodenal ulcer.

On February 4, 1930 (two and one-half months post-operative) he complained of occasional gas but has had no pain and has gained in weight. Fleuroscopic examination and films made at this time presented no evidence of duodenal ulcer.

This patient was presented because he offered a rather unusual occurrence of perforation of a gastric ulcer, followed seven months later by perforation of an acute duodenal ulcer and presents no X-ray evidence of duodenal abnormality twenty-three days post-operative. In a series of ninety-two per-

forated ulcers he had seen two other cases of recurrent perforation—one similar to the case presented—the other a recurrent duodenal perforation.

Dr. John Douglas said that it had often been his experience, in these cases of recurrent ulcers, to find there was present somewhere in the body a focus of infection, frequently carious teeth. Also, with carious teeth, they do not properly masticate food. Whether or not, however, this has anything to do with the etiology of duodenal or gastric ulcer, it is important in these cases to get the teeth cleaned, if possible before operation, or otherwise before they leave the hospital.

CARCINOMA OF RECTUM

Dr. W. F. Cunningham presented a woman, fifty-four years of age, who was admitted to the First Surgical Division of Bellevue Hospital January 8, 1927. For six months she had suffered from painful defecation with bleeding. The calibre of stools had been greatly reduced in size during this time. No history of diarrhœa, constipation or mucous discharge. She had lost weight but the amount, though considerable, was indefinite. For some months she had had pain along the course of the left sciatic nerve. Examination revealed, on the anterior rectal wall, beginning at level of sphincter and extending upward one and one-half inches and involving one-half the circumference of the rectum, an ulcerated area with indurated rolled edges. It was infiltrating the posterior vaginal wall. Biopsy showed this to be an adenocarcinoma.

January 17 a permanent sigmoid colostomy was made and forty-eight hours later this loop was opened by cautery.

January 29 the following procedure was performed. The tumor mass in the rectum invaded the posterior vaginal wall over an area six by two centimetres. Incisions were made in the vaginal wall postero-laterally, deepened and carried through so as to surround the rectum, circumscribing the perineal body, the sphincters and anus. The rectum was freed by sharp and blunt dissection with the posterior vaginal wall. The vaginal wall was then repaired and the rectum brought down for a distance of five inches and excised, the upper end being sutured to the skin margins. The wound was loosely packed with iodoform gauze. Post-operative reaction was slight but there was considerable free suppuration. The colostomy worked well. The patient was discharged from the hospital four weeks after operation. At the present time there is no evidence of local recurrence or remote metastasis. The post-vaginal wall is intact, the perineum is represented by a thin shred of skin, and rectal mucosa remains at the edge of the skin incision. While the operative procedure was intended as a palliation simplex, done to prevent extensive recto-vaginal ulceration and its associated unpleasantness, it has given an extremely satisfactory surgical result over a three-year period.

KNEE-JOINT ARTHROTOMY FOR HYPERTROPHIC OSTEOARTHRITIS

Dr. John J. Moorhead presented a woman whose left knee had been a source of trouble for eighteen years, but had been an actual disabling feature for three years. Pain limitation of motion and repeated swelling of the joint had been the main symptoms. Various forms of internal treatment together with a course of vaccines proved unavailing. Physiotherapy likewise gave no lasting effects. Foci of infection have been diligently searched for.

She was first seen by the reporter November 17, 1927. At that time the left knee was in a flexed position, fifteen degrees off a straight line, and

could not be straightened therefrom. Flexion was limited to a right angle. There was considerable atrophy of the calf and thigh and there was a sharp tenderness over the external semilunar region. There was fibrous crepitation in the enlarged joint. No heat; X-rays negative.

February 16, 1928, at Post-Graduate Hospital, a medio-lateral arthrotomy was performed under strict Lane technic, a tourniquet being used. The findings were hypertrophic synovitis with an erosion of both semilunars and hypertrophy of the subpatellar fat pads. Both semilunars were excised together with a part of the subpatellar fat pads and the synovial lining. She made a very satisfactory recovery and two months later she estimated that she had a 75 per cent. improvement as to pain and function. In October, eight months after the operation, she stated that she had walked a distance of seven miles without limping. At the present time the knee-joint motion is practically complete and she has little if any pain. Here is a case of long-standing intra-articular involvement which twenty-six months after operation shows practically a perfect outcome.

He had had a number of similar cases and in all had performed 143 knee-joint arthrotomies by this same ultra-aseptic technic. Fifty-nine of these cases were reported before this Society in November, 1925. His conviction is that there are a large number of these knee-joint cases in which surgery is indicated. All, of course, realize that knee-joint calculi (damaged semilunars, exostoses or the like) are subjects for arthrotomy. There is, however, in addition, a large group in which arthritis with or without injury is the main factor and it is into that class that this case falls.

Dr. CLAY RAY MURRAY queried the condition of the alar ligaments in this case. He had sometimes found evidence of crushing of these ligaments in similar cases, producing effusion and even locking the joint as they are pinched between tibia and femur. Was it possible that such a condition accounted for the symptoms in the case presented?

DOCTOR MOORHEAD added that in this case the patella was dislocated to the outer side and that no muscle fibres were cut inasmuch as the vastus internus was separated in much the same manner as the rectus in a laparotomy. After the lateral compartments had been exposed, the knee was bent and, if necessary, the incision was lengthened and thus, with rotation, the external semilunar could also be exposed. The Jones patella split operation had been abandoned some years ago because this medio-lateral incision gave just as good access without interfering with the knee pan. A smaller incision has also been abandoned because experience has shown that there is usually a combination of pathology in the joint even though the symptoms may point to one major process.

BILATERAL SUBCUTANEOUS RUPTURED QUADRICEPS

Dr. JOHN J. MOORHEAD presented a woman who, on October 18, 1924, tripped on stairs and fell three steps. She was in bed ten days and subsequently needed a crutch and cane. She was first seen by the reporter September 15, 1926. Her right knee was painful, and, when flexed, could not be extended. There was considerable atrophy of the right thigh and leg. There was a distinct gap, three fingers wide, between the top of the patella

and the lower end of the quadriceps. There was evidence of hypertrophic arthritis around both knee-joints.

At operation at Post-Graduate Hospital, September 28, 1926, it was found that there had been a subcutaneous laceration of the quadriceps tendon close to its attachment and that there was evidence of calcification thereof. The edges were freshened and chromic sutures were applied and a posterior splint was attached. She recovered fairly well and had greater control of the extension. February 9, 1927, the knee gave way and she fell and thereafter there was considerable loss of function, so that March 14, 1927, she was re-operated upon and a double pedicle flap was fashioned by turning down the margins of the quadriceps tendon. Reinforcement was made by drilling holes through the patella. Since then she has regained only partial function in this right knee.

September 21, 1929, she fell and injured the left knee and on the twenty-third of September, the left quadriceps was sutured, reinforcement being made through holes drilled in the top of the patella. She has made a most satisfactory recovery as to the left knee.

This is a case in which several operations have been performed—on one side after a lapse of two years and on the opposite side after a lapse of two days; and the contrast in end results is apparent.

DR. ROBERT H. KENNEDY thought this case an excellent example of the result of early operation. He had occasion ten years ago to attend a man who had a bilateral rupture of the quadriceps extensor tendons about one-quarter inch above the patella, through an automobile accident. He was operated on four days later. The ruptured tendons and joint capsules were sutured in layers on both sides and the extremities immobilized for four weeks. He was a very stout man and for some years had felt that his knees were unstable in walking. He was last seen twenty months after operation when he felt that his legs were much more stable. At that time function of both lower extremities was complete and he had no complaints.

DR. CLAY RAY MURRAY emphasized the difficulties encountered in late operative treatment of these cases, both in identifying structures and pathology, and in securing full functional recovery. Failure to institute primary operative treatment is often due to too superficial examination and the ready diagnosis of traumatic synovitis. In a recently operated case of rupture of the patellar tendon of eleven months' duration with total loss of extension, this had been the diagnosis made at the time of the original injury, and the sole treatment had been rest and physio-therapy. At operation, eleven months after the injury, it was extremely difficult to spell out the pathology and identify in the scar tissue the site of the original tear in the tendon and in the lateral expansions. Any knee-joint which shows effusion into the joint very shortly after injury is a hemarthrosis and not a synovitis, and should be carefully examined for a lesion capable of producing a hemarthrosis.

DR. HUGH AUCHINCLOSS referred to a man, about sixty-five years of age, whom he had cared for, who had sustained a complete fracture of the quadriceps tendon just above the patella incidental to taking an unexpected step down from the curb. The patella had remained intact. Repair was made by weaving a broad fascial strip cut from the tensor fasciæ femoris, starting

just below and encircling the patella, into the quadriceps muscle above. The repair seemed firm and the motion of the knee good. Several months later he was knocked down by a taxi-cab and run over, a rear wheel passing over the lower end of the same thigh. The driver braked suddenly and brought his car to a stop so that the wheel was resting practically on the site of the former injury when the patient shouted to him to move on so the leg could be freed. A large hematoma resulted, that had to be evacuated, but it is interesting to note that the repair of the ruptured quadriceps tendon was not affected. These cases are not so frequent that the technic for their repair has become standardized. This method, by means of the fascial suture, worked so well that it is perhaps worth while recording.

DEPRESSED FRACTURE OF CHEST WALL WITH HERNIA OF LUNG

DR. JOHN J. MOORHEAD presented a man who, May 22, 1929, fell through an elevator shaft, a distance of twenty to twenty-five feet, striking upper part of front of right chest against a projection. He was three weeks in a local hospital where the treatment was rest in bed and strapping of the chest wall for broken ribs. He was first seen by the reporter November 15, 1929. At that time he complained of a bulging in the right upper chest with pain and disability in the same location. He had not returned to work since the date of accident. This bulging and pain were increased on coughing or straining. On deep expiration a mass could be made to appear in the right upper chest. Examination at that time showed a visible and palpable ridge of bone on the inner side of the right nipple and this marked a cup-like depression in the neighborhood of the nipple approximately four inches by one and one-half inches in size. The musculature in this neighborhood was definitely flabby and atrophic and the general appearance was a sunken-in section of the chest wall. On moving or deep expiration a bulging in this hollowed-out area appeared in size equal to half a good-sized orange. It immediately disappeared at the end of expiration and apparently was a hernia of the lung.

December 7, 1929, at the Post-Graduate Hospital under gas-oxygen-ether anæsthesia, a semi-circular incision was made exposing this area and it was then found that the third, fourth and fifth ribs were markedly depressed and overlapping. In the centre of this depressed area a mass appeared at each act of expiration and when it had been dissected down to its base, it was found to represent a thick pleura which escaped from a gap between the broken ribs, the base of this hernia sac being about one and one-half inches in diameter. When it was opened there was an immediate collapse of the underlying lung. The base of the sac was transfixed and inverted after the manner of an ordinary hernia; the intercostal and pectoral muscles were plicated after the third rib had been elevated into a better position and a stab wound drain was inserted in the neighborhood of the axilla. In general the approach was similar to that made on the inner half of an excision of the breast.

He had a stormy convalescence and developed a post-operative pneumonia on the right side and a hematoma formed along attachments of his pectoralis major. This became infected and a secondary drainage opening was made. He was discharged from the hospital December 29, 1929. The wound is entirely closed now except for a small sinus which apparently leads down to the necrotic end of one of the fractured ribs.

There has been no recurrence of the hernia despite the apparent gap in the

bone cage of the chest. He has gained twenty-five pounds since leaving the hospital.

OSTEOMYELITIS OF TIBIA WITH SECONDARY BONE GRAFT

Dr. William Crawford White presented a boy, eight years of age, when admitted to Roosevelt Hospital on December 18, 1926, with a diagnosis of chronic suppurative osteomyelitis of left tibia, right humerus, and

Fig. 1.—When admitted to hospital.
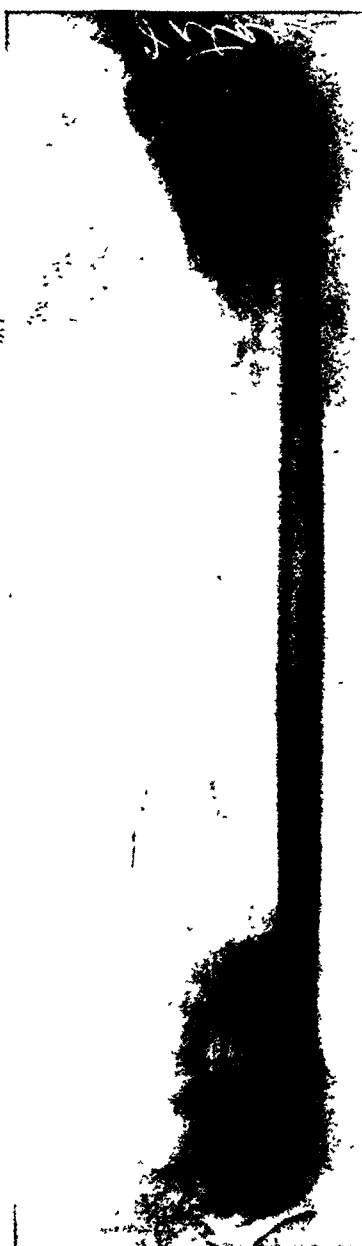
Fig. 2.—After first operation.

right femur. He had been sick for eight weeks following a scratch on his left ankle with the edge of a roller skate. Two days afterward, this scratched abrasion became painful, swollen and red. The local condition was treated by his physician who incised and drained the abscess. Subsequently swelling in the right shoulder and right knee region developed. Both these areas were incised and drained. Culture showed staphylococcus aureus.

On December 31, 1926, he was operated upon by the speaker who then found extensive metaphysis involvement and it appeared that the whole bone

was destroyed. There was thick white pus in the medulla. A subperiosteal removal of the metaphysis was then performed with a Giglee saw. The bone was cut across just proximal to the distal epiphysis and just distal to the upper epithysis. The wound was partly packed with iodoform gauze but for the most part the periosteum was approximated with interrupted plain catgut. A posterior plaster splint was applied.

Leg suspension and traction was used for the left lower extremity. Bone regeneration was extremely slow in the left tibia. He remained in the hos-

FIG. 3.—Skiagram taken April 10, 1928, showing maximum periosteal growth.

FIG. 4.—Two months after bone grafting.

FIG. 5.—Present condition. Two years after bone grafting.

pital for six months and at the time of discharge there was no new bone at the lower portion of the wound. He was discharged to the dispensary on June 13, 1926.

He was seen from time to time in the Recall Clinic, and the condition appeared to remain the same. He was still walking on crutches and used a molded plaster splint. It was decided that a bone graft might help the condition. The leg wound was healed.

On April 13, 1928, about sixteen months after the first operation, a bone graft was taken from the right leg and inserted into the left leg. Bone had been well formed in the upper part of the left tibia but it narrowed down rapidly in a cone-shaped fashion until at the junction of the middle and lower third there was a space about three inches long with no bone, just a tube of periosteal tissue. (Fig. 3.) Beyond this, there was new bone formation in the diaphysis which was soft and crumbly. A longitudinal incision along the anterior inner surface of the left leg was made with exposure from the upper end of the bone to the lower end. Incision of periosteum which was stripped back. Along the inner side of this new bone in the middle third a strip of bone was removed. A slot was made in the lower end and also in the upper end of the new bone. This gave a length of eight inches to be filled with grafts. An eight-inch graft about five-eighths inch in width was removed with periosteum from the right tibia. This was placed in the slot prepared for it in the left leg and held in place by circular kangaroo tendon sutures. The wound was closed with drainage.

June 9, 1928, a plaster circular splint applied. On the fifty-seventh day the splint was removed and the wound was examined. There were three sinuses present; one at the upper end of the scar and two at the lower end, with some yellow pus. The leg was dressed and placed in a posterior wire splint. On June 26, 1928, he was discharged to the dispensary with a posterior splint on his seventy-fourth day. He was kept on crutches with a posterior splint.

In October, 1928, X-ray showed a complete osseous bridge. Subsequently there has been a slow but steady improvement and in June, 1929, he was allowed to walk without any support. On April 5, 1930, he was examined and found to have one and one-half inches of shortening of the left leg as compared to the right. He walks on his left toes to compensate. The wound is completely healed and there is good firm bone. There is complete motion at the left ankle-joint and left knee-joint. There is no rotation of the lower part of the leg on the upper part.

This boy was shown, not to demonstrate the value of subperiosteal resection for acute osteomyelitis, but to demonstrate regeneration of bone in an area that had been chronically infected, not one in which regeneration had recurred from the periosteum. DR. JAMES I. RUSSELL has shown before this Society a number of similar subperiosteal resections with regeneration of bone, and this is the first case that had failed to regenerate.

DR. KIRBY DWIGHT said that an interesting thing about these bone grafts was that a small amount of infection did not vitiate the graft. Bone grafting is so frequently done in cases in which there has been long-standing infection that there are likely to be residual bacteria in the scar tissue and the best of them may become infected. One might be tempted to discouragement on seeing pus appear, seeping through the plaster cast, but this is a mistake. Union may take place even though a sinus has formed and persists for some time.

DR. FREDERIC W. BANCROFT remarked as to complete subperiosteal resection in cases of acute osteomyelitis that Nichols, a number of years ago, advised removal of the sequestrum after the involucrum had become one to two millimetres in thickness. This would mean at about six to eight weeks after the primary drainage of the medulla. He advised in these cases the

suture of the periosteum and the occlusion of the dead space, but it was at a time when new bone had already started to proliferate.

In a discussion held recently in Philadelphia, Doctor Pfeiffer, in a study of a series of cases, showed that the operative procedure which drained the metaphysis inflicting the minimum amount of trauma had produced the best results. It was generally felt that the stripping of the periosteum and curettage of the medullary canal were inadvisable, as they might cause further interference with the blood-supply of bone which had already received considerable damage by infection.

Doctor White, in closing the discussion, replied to Doctor Bancroft that this subperiosteal resection had not been done since 1926, but he felt that there were indications for the operation at times as this had been the only case in a series of five that had failed to reform bone. This case, however, was not shown to demonstrate a poor result from periosteal resection; rather, it was shown to demonstrate the formation of new bone in an infected area by the use of a bone graft with periosteum. Before the operation the limb was useless; now there is bone continuity with a useful limb.

RAT-BITE FEVER

Dr. William Crawford White presented a negro baby boy, aged eight months, who was admitted to the Surgical Service of Roosevelt Hospital June 7, 1929. He remained there three days when he was discharged. He was readmitted three days later and finally discharged at the end of seven weeks.

A high fever was noted on first admission. This came down by crises to normal on the following day. The history stated that three weeks before admission the child was bitten by a rat on the upper and lower lips. He was taken to another hospital where the wound was treated. About ten days later both lips began to swell. This was associated with some fever.

On admission to the Roosevelt Hospital the child appeared acutely ill with a fever of 104.6°. Both lips were swollen and indurated, while the sublingual, submaxillary, and cervical lymph nodes were enlarged. No rash was noted. At that time a diagnosis of cellulitis of the upper and lower lips with cervical adenitis was made. Wet dressings were applied, and after three days the child was sent home.

He returned three days later with a fever of 103.6°. By this time the swelling of the lips had almost disappeared, but the cervical lymph nodes were enlarged. The child appeared sick, and it was then that serological tests were made and blood cultures taken. Except for a moderate rachitic condition the examination was essentially negative. A sample of the patient's blood showed a few spirochætæ by means of the dark field illumination. A rare one was found by means of an unstained smear. The organisms were morphologically identical with spirochætæ morsus muris. Three mice and one guinea pig were inoculated (infraperitoneal) with the patient's blood and treated in the same manner as in the search for trypanosome. Nineteen days later the inoculated guinea pig died. Spirochætæ were demonstrated from the profuse discharge from the nose and mouth, also a few from the bloodstream. The organisms from the nasal discharge were numerous, about seven to ten per high power field. The blood Wassermann was negative. It is of

interest to note that in some cases of the rat-bite fever it is positive. The white blood cell count was 16,000, with polymorphonuclears 65 per cent.

Treatment was started and .5 grams of sulpharsphenamine was given in the muscle at three-day intervals for four injections. The child was discharged cured on the fifty-third day.

Whenever there is a history of a bite by an animal, especially a rat, a blood-stream invasion by this organism should be kept in mind, and the case should not be discharged when the surgical wound has healed, but the patient should be kept under observation for the period of incubation.

To summarize, Rat-bite Fever is:

1. A disease caused by the bite of an infected rat.

2. It is characterized by a relapsing type of fever, with a moderate or severe toxemia, a characteristic xanthema, and a local inflammation at the bite area with adjacent lymph adenitis.

3. It is caused by the spirochæta morsus muris.

4. The incubation period varies from ten to twenty-eight days, with an average of two weeks.

5. The mortality has been placed at 10 per cent., but this should be lowered by treatment with salvarsan.

SUBACUTE PANCREATITIS OR SO-CALLED ACUTE ŒDEMA OF THE PANCREAS

Dr. DeWitt Stetten read a paper with the above title, for which, with discussion, see page 248.

BRIEF COMMUNICATION

INSULIN IN THE TREATMENT OF NON-DIABETIC BED SORES

INSULIN is a proven remedy in indolent ulcers. Decubitus is, for the most part, not only indolent but progressive. Due to the invasion of secondary infection, it is sometimes the direct cause of death in a lingering or exhausting disease. Since the introduction of insulin, occasion has arisen to use it by the reporter in five cases of decubitus in non-diabetic patients. The results were uniformly satisfactory.

CASE I.—Female, aged sixty-four, Para VI, has had cardiac trouble for over twenty years. There is a history of several decompensations and several nervous, bordering on mental, breakdowns. Albumin and casts were repeatedly found in the urine but never glucose. Wassermann negative. Eight weeks ago patient suffered from cardiac decompensation and mental breakdown. In addition there were cramps in the legs and intense pains in the course of the sacral and crural nerves. Hæmorrhoids which were always a complicative factor became more bothersome, and urinary and fecal incontinence became frequent of occurrence. A bed sore in the coccygeal region which developed about four weeks previously kept spreading and added greatly to the complexity of the situation. Scrupulous cleanliness and various ointments seemed to make no difference in the progress of the ulceration which by then occupied an irregular area of about three and one-half by two and one-half inches, was sloughy and deep. Through the courtesy of Dr. L. Spiegel, insulin injections were now instituted, fifteen units before dinner. Improvement began almost immediately and at the tenth injection the bed sore had diminished to about one-fifth its former size and had become quite superficial in depth. There was a marked improvement in the mental symptoms and the incontinence disappeared almost entirely. The tenth injection was followed by insulin shock, but was controlled by the administration of orange juice and sugar water. She received no further insulin for five days, but the decubitus kept progressively healing, when it was again instituted on alternate days. At the time of the fourteenth injection a pin-head opening was all that remained of the original sore.

CASE II.—Male, aged sixty-eight, suffering chiefly from cardiovascular disturbances. Wassermann negative. Blood sugar content on three different examinations averaged 160, and urine, over a period of one year, showed a trace of sugar (calculated as one-tenth of 1 per cent.). During an attack of apparent grippe the patient was put to bed. Sacral decubitus developed about two weeks later and one on the left heel about a week after that. Surgical cleanliness and ointments were of no avail. Patient was started on five units of insulin two times a day. A change for the better was noticeable on the third day, and on the eighth day, after the initial injection, the sacral sore was about half its original size; the heel sore remained stationary. Ten units (making a total of fifteen units a day) were then administered before the evening meal and the improvement became more noticeable still. The sore in the heel seemed to make even better progress than that in the sacrum. The general physical condition showed marked improvement, but inasmuch as other stimulating therapy was administered, the action of the insulin was duly discounted. The patient died of pulmonary œdema three months later, after being out of bed for more than a month prior to his death. The sacral bed sore was completely healed and only a very superficial and very small granulating surface remained under the left heel. The insulin treatment was

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reduced to five units once a day for six weeks, and discontinued entirely four weeks prior to death.

CASE III.—Female, aged fifty-eight, with a blood-pressure of 240/120 to 180/90, was diagnosed as luetic with apparent early paresis. Wassermann negative. Spinal puncture was not permitted. One of the pupils was immobile to light and the other reacted faintly. Knee-jerks could not be obtained (patient was then in bed). Urine always negative to sugar. A sacral bed sore developed rapidly after about ten days in bed in spite of excellent physical care. The mental symptoms, chiefly noisily irrational, increased in severity. Insulin injections, ten units once a day, were instituted, at which time the sore was about four inches in diameter, necrotic almost down to the bone. In less than two weeks the ulcer had decreased about one-half and healthy granulating tissue was everywhere present. There was a definite improvement in the mental status. In five weeks' time there remained but a small superficial ulcer. The mental condition was much improved. It is but fair to add that mixed treatment and mercurial inunctions were used at the same time. About one year later this patient died of a cerebral embolus.

CASE IV.—Female, aged thirty-nine, with a pulmonary abscess following pneumonia. She was ambulatory for several months after a successful partial thoradectomy. Due to a fresh infection she was compelled to go to bed. Temperature ranged from 101° to 103.5°. Emaciation was rather rapid and a sacral decubitus developed in about three weeks' time. Spleen was enlarged. Diagnosis, proven by X-ray, was further pulmonary involvement in region of the first lesion. No sugar was found in repeated examinations of the urine. Bence-Jones' reaction positive. The decubitus at the time the insulin treatment was instituted was sloughy and about two inches in diametre. Dosage ten units once a day. In ten days' time it had all but disappeared. The general condition was distinctly improved (for about three days the temperature was normal, and appetite, which was very poor from the start, became normal). A new infection apparently again made its appearance and the patient died of exhaustion and in coma fourteen weeks after she went to bed. The decubitus never recurred, although its original site became bluish-black twenty-four hours before demise. There had been no insulin treatments for over six weeks before death.

CASE V.—Probably the most rapid results were obtained in a female, aged sixty-two, suffering from a severe non-malignant cystitis. When for better control she was ordered to bed, she developed a small sacral and a larger left sacro-iliac sore. Insulin injections of fifteen units (divided in five and ten), daily, cured both in ten days' time. The sacro-iliac sore was one and one-half inches in its greatest width when the insulin treatment was begun. The cystitis immediately improved. There was partial incontinence before the patient went to bed, but due to the physical care it apparently did not enter as a factor in the development of the decubitus. The patient has remained well a year and a half after the last insulin treatment.

In all the above, other remedies had been used in addition to the insulin, but were for the most part discontinued as soon as the insulin was begun. With the exception of the patient with the pulmonary abscess, the others suffered clinically, at least, from degenerative vascular disease—the so-called arteriosclerosis. Experience with the treatment of decubitus in the presence of vascular degenerative disease is unpleasant at its best. An agent which modifies their course more favorably than any other treatment is apparently to be found in insulin.

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BOOK REVIEW

DISEASES OF THE URINARY TRACT IN CHILDREN. By EDWIN BEER, M.D., AND ABRAHAM HYMAN, M.D. Quarto; pp. 311; 50 illustrations. Paul B. Hoeber, New York, 1930.

THIS volume presents the personal experiences of the past twenty years of the authors in the study of diseases of the urinary tract in young children, representing mostly their observations in the wards of the Mt. Sinai Hospital. The subject is dealt with by them from a diagnostic, pathologic and therapeutic standpoint.

Diagnostic work in this field received very great impetus by the introduction to the surgical armamentarium of a child's cystoscope in 1907 which from then on placed the study of these diseases on a much more accurate basis, although not entirely commensurate with that obtained in the study of adults. Much effort has been made to show the conditions of the genito-urinary organs which have their incipiency in childhood but are not usually recognized until the second or third decades. The usual deformities of the genitalia which have heretofore been thoroughly recorded in the usual text-books are considered merely in their relation to the consequent damage in the urinary tract proper.

The book is comprised of fourteen chapters which represent the general pathologic conditions of the genito-urinary system as far as the bladder. Those considering the general symptoms and methods of examination well repay careful study. The introduction of uroselectan, while still in what might be called an experimental stage, has already proved its value in the diagnosis of pathologic conditions, particularly in children, while mechanical manipulation of the cystoscope and ureteral catheter has, at times, proved most difficult and unsatisfactory. The intravenous use of this chemical can be employed under conditions where no such armamentarium as is necessary can be obtained. Illustrations of this procedure are introduced into the book and are most instructive.

It is felt that the present work will unquestionably prove a definite stimulus to more extensive endeavor in the recognition of diseased conditions of the urinary tract in children, not only to the pediatrician, but also to the surgeon and to the urologist.

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THE INFLUENCE OF HYPERTHYROIDISM UPON THE SECRETION OF FREE HYDROCHLORIC ACID

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THE realization of the fact that certain glands within the body produce secretions which pass directly into the blood-stream has given rise to a multitude of investigations to determine the influence these secretions have either upon the body as a whole or upon the integral parts of the body. During the past decade, a voluminous literature has accumulated on the subject without any very definite solution of the major problem; but many interesting and valuable points have been determined. The clinical pictures that accompany hyper- and hypo- function of each of these glands have been studied with extreme thoroughness, but the determination that these pictures are by no means clear-cut has led to a great amount of confusion as to exactly what part the glands of internal secretion play in body metabolism. As is well known, these glands are very closely interrelated in their activities and this accounts for much of the difference of opinion. It is almost impossible to study the effects produced on the body as a whole by the secretion of one of these organs without considering the others. Yet dysfunction of one of these glands alone is known to produce certain clinical manifestations with some degree of constancy and it is the object of this paper to report a series of observations made in patients suffering from altered thyroid function with special reference to the influence exerted through the autonomic nervous system upon the secretion of hydrochloric acid in the stomach and endeavor to correlate this with the other symptoms of hyperthyroidism.

That the thyroid gland produces its effects on the body through its secretion, the so-called thyroxin, is assumed. Its action is chiefly concerned with the metabolism of the body cells. The effect that an over-amount of this hormone may have on the different organs of the body has been studied quite extensively though the manner in which it acts has been a matter of much controversy. Recent reports to the effect that dysfunction of the thyroid gland may alter gastric secretion have opened up another field for investigation. A review of the literature, however, shows that it is a matter of some dispute whether it is hyperthyroidism or hypothyroidism that raises or lowers the gastric secretion so far as the presence of hydrochloric acid is concerned.

The influence of thyroid dysfunction upon the production of hydrochloric acid.—In a study of five cases of myxœdema in which gastric analyses were

made, Sturgis[1] reports an achylia gastrica in three cases, a low acidity in one, and normal acidity in the fifth case. Lockwood's[2] results show an achlorhydria in six of the ten cases which he reported. Stone[3] found a persistent achlorhydria to exist in four, or twenty-five per cent., of the sixteen cases of myxœdema in which the gastric contents were examined. The results of clinical and experimental investigations that have been reported by other observers, however, make it a bit difficult to explain these findings. Katz,[4] for example, cured several cases of hyperacidity found in patients with myxœdema by the administration of thyroid extract. Hardt[5] noted a depression of both gastric secretion and acidity in patients who were given thyroid extract. Schnabel[6] reports cases of achylia gastrica made worse by treatment with thyroid extract. Levy[7] examined ten cases in which the basal metabolic rate varied from a minus 13 per cent. to a minus 25 per cent. Nine of these showed a definite hyperacidity and only one showed achlorhydria. In two of the cases with hyperacidity, thyroid extract medication resulted in a reduction of hydrochloric acid. Boenheim,[8] Rogers,[9] and Truesdale[10] carried on experiments in thyroid feeding on dogs with conflicting results, and it is difficult to determine from their findings the effect thyroid feeding has on gastric secretion since their analyses were carried out over too short a period. Moreover, they estimated only the volume of the secretion and the total acidity, not the free hydrochloric acid. Hardt[5] fed ten grams of desiccated thyroid gland to two dogs daily for two weeks. Gastric analyses were then made, the collection of the samples being started one hour before test-meals and completed one hour after feeding. As the result of his experiments he reports no indication of either hyperacidity or hypersecretion following the administration of the thyroid extract. In both dogs, on the contrary, there was a tendency toward depression of the acidity and rate of secretion. The acidity returned to normal a few days after the thyroid feeding was discontinued. Moll and Flint[11] repeated these experiments on four dogs with Janeway fistulæ. Fractional analyses were carried out over a period of five hours. In two cases thyroid feeding produced almost complete achlorhydria. In the third dog subacidity was noted but in the fourth animal there was a slight rise in acidity. Following up these experiments Chang and Sloan[12] (working under Carlson), found that thyroid feeding was capable of decreasing gastric secretion both in amount and percentage of hydrochloric acid. They found also that thyroidectomy in dogs resulted in a decided increase in the volume of the gastric juice and a less marked but demonstrable increase in acidity. Thyroid feeding subsequent to the thyroidectomy was capable of again depressing gastric secretion which came back to its previous level when the thyroid feeding was stopped. The mass of experimental evidence, therefore, would lead to the conclusion that hypothyroidism produces increased acidity whereas hyperthyroidism causes a decrease in gastric acidity.

The above findings, which appear to be contradictory, may possibly be explained as follows: myxœdema is often an end-result of hyperthyroidism and represents nature's sure cure of the condition. The oversecreting gland finally wears itself out and instead of secreting too much hormone secretes too little or none at all and a condition of athyroidism or myxœdema results. If this is the case a condition of hypoacidity or achlorhydria initiated by the preliminary hyperthyroidism would probably persist because of the inability of the acid-secreting cells to reëstablish their function after an inhibitory

stimulus of long duration had been removed. The animal experiments, however, being carried out on glands that were practically normal, would tend to show that an increased amount of thyroid hormone tended to cause hypoacidity. Further experimentation will be necessary before the meaning of these observations can be definitely determined.

Neilson[13] makes the statement that hyperacidity is frequent in hyperthyroidism and Boenheim[8] is of the same opinion. Maranon[14] has observed crises of hyperacidity. Sajous[15] states that excessive thyroid secretion causes increased metabolism in the gastro-intestinal mucous membrane and muscles, manifested by hyperchlorhydria, gastro-succorrhœa, frequent vomiting, diarrhœa, and serous light-colored stools. These findings are again contradicted by King[16] who reports achlorhydria to be present in cases of exophthalmic goitre despite an increased stomach and intestinal motility. Barker[17] states that there are certain cases of exophthalmic goitre in which the gastric secretion is increased, though, as a rule, it is diminished. Wolpe[18] found achylia gastrica to be constant in all definite cases of exophthalmic goitre, but in other types of hyperthyroidism the hydrochloric acid was unchanged. Leist[19] found achlorhydria present in seven out of eight cases of exophthamic goitre and explained his findings on the basis of a subnormal protein content of the blood-stream rather than upon hormone action.

Lockwood,[2] in a study of ninety cases of definite hyperthyroidism, made gastric analyses in twenty-four cases which presented digestive disturbances. In ten of these there was an achlorhydria present; three showed hypochlorhydria and eleven showed normal acidity. As a result of these studies he concluded that achlorhydria was present more often in severe cases and that it was more frequent in cases of exophthalmic goitre than in the forme fruste and in the adenomatous types.

H. Moll[11] made a study of fifty cases of hyperthyroidism. He divided his cases into five groups as follows:

	Achlorhydria	Hypochlorhydria	Normal	High N.
Chronic Graves' disease of more than two years' standing	15	6	1	1
Acute Graves' disease of less than one year's standing	4	4	3	–
Toxic adenoma	–	4	2	1
Forme fruste	3	–	2	1
Puberty hyperplasia	–	1	1	1
Totals	22	15	9	4

The conclusions he drew from these findings were: (1) that there is a constant tendency toward subnormal or absent secretion of hydrochloric acid in Graves' disease; (2) that the achlorhydria is more frequently found in cases of long standing, while in the more acute cases the gastric secretion is least diminished; (3) that the secretion of hydrochloric acid in cases of toxic adenoma and puberty hyperplasia is usually normal or subnormal, but that acid is never absent.

Gastric Analyses in Hyperthyroidism.—Twenty patients showing symptoms of hyperthyroidism have been studied with special reference to changes in the secretion of free hydrochloric acid. Analyses were made by the

TABLE I

Series of Twenty Cases

	Achlo-rhydria	Hypochlo-rhydria	Normal	Hyperchlo-rhydria
Hyperthyroidism more than two years	4	1	2	0
Hyperthyroidism one to two years...	3	3	1	0
Hyperthroidism less than one year...	4	1	1	0
Totals.........................	11	5	4	0

fractional method over a period of two hours in all but three of these cases. In these the Ewald method was used. The results show that in this series eleven patients were found to have achlorhydria; five presented a hypochlorhydria and only four a normal acidity. In no instance was hyperchlorhydria present.

Table I shows the results in this series of cases classified according to the length of time that hyperthyroidism had been present. In this table no effort is made to classify the type of hyperthyroidism or whether eye symptoms were or were not present. The results seem to show very little except that possibly in the cases of short standing, less than one year, a larger percentage of cases shows a complete achorhydria than when the disease had been present for a longer period. Whether this can be interpreted as meaning that the early action of the altered thyroid secretion upon the sympathetic nervous system is to inhibit completely the secretion of acid temporarily and permit the ability to secrete acid to be regained subsequently as the sympathetic nervous system recovers from the attack or becomes unaffected by the stimulation of the thyroid secretion is a question which can be settled only by the examination of a much larger series of cases.

TABLE II

	Achlo-rhydria	Hypochlo-rhydria	Normal	Hyperchlo-rhydria
Exophthalmospresent	7	1	4	0
Exophthalmos absent.............	4	4	0	0
Totals.........................	11	5	4	0

In Table II the cases are classified as to whether exophthalmos was or was not present. In the cases in which exophthalmos was present a larger percentage shows achlorhydria but also a larger percentage shows a normal

TABLE III

	Achlo-rhydria	Hypochlo-rhydria	Normal	Hyperchlo-rhydria
No fibrillation......................	8	4	3	0
Temporary fibrillation..............	2	0	0	0
Fibrillation fixed and remaining after operation......................	1	1	1	0
Totals.........................	11	5	4	0

acidity. In other words, when exophthalmos is present there is apt to be either achlorhydria or a normal acid finding. In cases in which exophthalmos is absent there is found either achlorhydria or diminished acid secretion with no cases in which normal acidity is present.

In Table III the cases are classified as to whether or not fibrillation of the heart was present and if present whether it was: (1) temporary fibrillation which either disappeared under the use of Lugol's solution before operation or disappeared after operation; or (2) fixed fibrillation which was present at all times before operation and has persisted unchanged following operation. In the series in which fibrillation was not present the percentage of achlorhydria is about the same as in the other groups. When the fibrillation was temporary there were two cases of achlorhydria with no cases of diminished acid and none of normal acid. With fixed fibrillation remaining after operation there was one case in each group. The results in this table are interesting in that they appear to bear out the suggestion made previously that in the early cases of hyperthyroidism which are usually acute cases the secretion of hydrochloric acid is apt to be entirely absent or is markedly diminished. Temporary fibrillation occurs in the most acute cases of hyperthyroidism. It disappears under the exhibition of Lugol's solution and disappears immediately or shortly after operation. In this type of cases of temporary fibrillation, of which there are two in this series, there was achlorhydria in both with no cases presenting any diminution of acid or normal acid. In the cases of fixed fibrillation which are cases of long standing, there is one case in each group; one of these I have had the opportunity of examining some two years after operation and the patient still shows a complete absence of free hydrochloric acid.

This series of cases adds additional proof to the reports already on record, that an increased thyroid secretion diminishes the secretion of hydrochloric acid in the stomach. The mechanism by which the excess of thyroxin inhibits the secretion of acid has not been described, and an attempt at an explanation of this mechanism must necessarily include, first, a study of the manner in which thyroxin exerts its effects on the body as a whole.

A point particularly emphasized by Crile[20] and observed by clinicians is, that a condition of hyperthyroidism is usually accompanied by emotional excitement. That the production of emotional excitement is a function of the sympathetic nervous system has been shown by Cannon.[21] It is entirely likely then that the thyroid secretion acts by stimulating the sympathetic nervous system, and experimental studies add proof to this supposition.

The close relationship that exists between the glands of internal secretion and the vegetative nervous system may, as Pottinger[22] has shown, be inferred from their developmental history.

He says, "Primitive forms of life are without nervous systems, and whatever response to stimuli and whatever correlation of action takes place in them does so through chemical action. Later in the stages of evolution, as the organism becomes more complex, a more accurate and more rapid coör-

dination is required. For this, in addition to the chemical control, a nervous system is developed. In the higher forms of life, then, we have this double reciprocal control of all involuntary or vegetative functions. Stimulation of the glands of internal secretion takes place through the vegetative nerves, and the hormones produced by the glands in turn stimulate vegetative nerve structures." Langdon Brown,[23] in discussing the relationship between the adrenals, thyroid, and pituitary, on the one hand, and the sympathetic nervous system, on the other, says: "This association is reciprocal—as not only does the sympathetic nervous system stimulate the secretion of these ductless glands, but their secretion increases, in turn, the sympathetic response."

A study of the pharmacological action of the endocrines brings out the fact that while they all act more or less on the nervous systems of the vegetative life, certain ones have a predilection for action on one part of one system. For example, the internal secretions of the thyroid and pituitary are found to act particularly as stimulants of the true sympathetic (thoracico-lumbar autonomic) system, but they act only on certain portions of this system, the pituitary acting primarily on the vasomotors and the parts under control of the inferior mesenteric ganglion, while the thyroid secretions stimulate the superior portions of this system (cervical and thoracic portions).

Clinical observations show that a condition of hyperthyroidism resembles sympatheticotonia (manifested by rapid heart, high blood-pressure, emotionability, heat waves, slow digestion, dermographism, goose flesh and febrile reaction), in contrast to vagotonia, the principal signs of which are narrow pupils, tendency to bradycardia, hypotension, respiratory arhythmia, palpitation and extrasystoles, eructation, aerophagia and gastro-intestinal hypersecretion.

The thyroid secretion is then apparently sympathicotropic in its action, and, as Oswald, Cannon and Levy[24] have suggested, has the property of sensitizing the sympathetics. Goetsch,[25] working on this theory and the fact that epinephrin selectively stimulates the sympathetic system, injected 0.5 cubic centimetre of 1/1000 epinephrin into patients with known exophthalmic goitre and dogs rendered experimentally hyperthyroid by feeding desiccated thyroid. As a result of his experiments, he concluded that an oversecretion of thyroxin makes the sympathetic nerve cells respond more quickly to the stimulus of the epinephrin than is normally the case. B. Chamberlain,[26] however, was unable to confirm these results.

For further evidence that an oversecretion of the thyroid gland maintains the thoracico-lumbar autonomica in a state of hyperexcitability, I have studied the effect of paravertebral cervical anaesthesia on the heart rate of hyperthyroid patients and have found that as soon as the overstimulation of the cardiac muscle is released by paralysis of its sympathetic innervation, the parasympathetic (vagus) control is able to exert its moderator effect and the heart is slowed.[36]

Since the thyroid exerts its effect on the heart through the sympathetic system, it would naturally exert its effect on gastric secretion in the same way. That gastric secretion is regulated in part by nervous influence has long been

known, but only recently has there been any knowledge of the effects of the various components of the gastric nerve supply on secretory activity.

According to Bickel,[27] the chief and parietal cells in the fundus are innervated by both parasympathetic and sympathetic fibres, which excite, and sympathetic fibres, which inhibit secretory activity. The secretion of water and hydrochloric acid is brought about chiefly by the parasympathetic (vagus) nerve fibres and to a much lesser extent by the sympathetic fibres. The sympathetic secretory fibres, however, exert the major influence in the secretion of enzymes, while the parasympathetic fibres play but a secondary rôle in this function. The sympathetic inhibitory fibres inhibit all secretory activity. Bickel states further that excitation and inhibition of gastric secretion is always mediated through the extrinsic nerves.

Carlson[28] refers to the use of drugs which affect the vegetative nervous system as a means of showing the relative rôle played by the sympathetics and parasympathetics in the stimulation and inhibition of gastric secretion. He refers to Ehrmann[29] and Skaller,[30] who found that pilocarpine and nicotine stimulate gastric secretion, and also to Keetah, Luckhardt and Koch[31] who found that atropine depresses the secretion. Hess and Gundlach[32] and Pal[33] show that atropine completely inhibits the secretion from food stimulation while it decreases but does not completely inhibit the secretion after stimulation by histamine and gastrines. According to de Vecchi,[34] who cited the experimental work of Foa, section of the sympathetic nerves in animals was followed by a marked increase, and section of the parasympathetics by a marked diminution in the quantity of hydrochloric acid secreted in the stomach. In addition, he reported two clinical cases in which resection of the vagus branches along the lesser curvature of the stomach was followed by a diminution in acid secretion, which was still appreciable after one and a half years.

Under normal physiological conditions, the secretory activity of the fundic glands usually ceases while the stomach is empty. This inhibition of the fundic glands, according to Bickel,[27] probably is due to inhibitory impulses of central nervous origin conveyed by sympathetic fibres to the fundus. With regard to the mechanism of gastric secretion Kuntz[35] states that: "When food is taken into the mouth, the stimulation of the sense organs involved and the accompanying psycho-physiological processes initiate strong reflex parasympathetic excitation, in the presence of which the central inhibitory influences, acting on the fundic glands, gradually subside, and these glands are thrown into secretory activity. As the food enters the stomach, it stimulates the gastric mucosa directly, first in the fundus, then in the pyloric region, and somewhat later in the duodenum, giving rise to afferent impulses which are conveyed by the general visceral afferents to the appropriate centers in the central nervous system. These, in turn, give rise to both secretory and inhibitory impulses which are conveyed back to the glands by general visceral efferent fibres. As the process of digestion progresses, the secretine produced by the active mucosa and the secretine-like substances contained in the food reach the intestine and, being absorbed, are added to the secretine already present in the blood. This, in turn, exerts an influence on the secretory activity of the gastric glands. As the food passes into the intestine, and the stomach once more becomes empty, both the reflex and humoral excitation of the gastric glands subside and the central inhibitory impulses again gain the ascendency, and the fundic glands become quiescent."

It is my belief that in conditions of hyperthyroidism this whole gastric mechanism is deranged, and whether it may or may not be completely held in check depends upon the amount of stimulation exerted by the alteration in thyroid hormone upon that portion of the sympathetic system supplying the inhibitory action to the acid-secreting cells of the gastric mucosa. It has been shown that an excess of thyroid secretion overstimulates the sympathetic nervous system until it reaches a high level of sensitization. When such a state exists, the stimuli produced by the process of ingestion and digestion, which normally excite the parasympathetic system until it has the upper hand over the sympathetic, are incapable of bringing about the desired effect, namely, the secretion of hydrochloric acid. The sympathetics are maintained at too high a level of excitability to be overcome or surpassed by the physiological stimulation of the parasympathetics.

When the effect of sympathetic stimulation upon the gastric mechanism is compared with the effects of the same stimulation upon the cardiac mechanism, the result, namely, absence or diminution of free hydrochloric acid, is exactly what would be expected. In the cardiac mechanism the stimulation of the cervical sympathetic cord, especially the middle and inferior ganglia, overexcites the accelerator fibres of the cardiac mechanism and overrides the depressor or vagotonic fibres and tachycardia results, whereas, in the gastric mechanism, as has been seen, the same stimulation of the same group of nerve fibres, namely, the sympathetics, depresses gastric secretion and results in a diminution of the secretion of water and free hydrochloric acid.

These findings would tend to show that thyroid symptomatology should be interpreted rather in the light of the portion of the sympathetic system which receives the greatest brunt of the altered thyroid hormone rather than in any definite change in the hormone itself, and that types of thyroid diseases may be classified according to the portion of the sympathetic system most affected by the changed secretion of the thyroid. If the upper portion of the cervical sympathetic chain bears the greater brunt of the toxic effect of the thyroid secretion the result will show itself in eye changes; namely, the different forms of exophthalmos while the cardiac symptoms may be less prominent and be confined to tachycardia, and the gastric symptoms may be less marked and the secretion of hydrochloric acid diminished to a lesser extent or not at all. If, on the other hand, the middle and lower portions of the cervical sympathetic are principally affected, the major symptoms of the thyroid intoxication will show themselves in cardiac manifestations, and it is in this type of case that one would expect to encounter tachycardia going on to fibrillation which will at first be temporary and later become fixed, and in this type the gastric changes may be more marked than in the upper cervical type. The fact that in the early stages of hyperthyroidism the gastric secretion of acid is absent more frequently than when the condition has become more or less chronic may be explained by the fact that in the early stage of acute hyperthyroidism the entire sympathetic chain is affected, giving rise to a temporary achlorhydria, while later, when the altered hormone of

the thyroid gland attacks that portion of the chain for which it has a definite affinity there will result either achlorhydria, diminution of free hydrochloric acid, or normal .secretion according to the a mount of stimulation exerted upon the gastric inhibitory sympathetic nerves by the altered thyroid hormone. In this interpretation of the mechanism of gastric secretion in hyperthyroidism hyperchlorhydria must be interpreted as an aberrant finding not due to the presence of the hyperthyroidism and, as the results show, the alteration in gastric acidity caused by hyperthyroidism tends always to a diminution from the normal.

CONCLUSIONS

From the above evidence the theory is offered that:

1. The symptoms of hyperthyroidism can be interpreted in terms of an increased sympathetic drive due to the action of the altered thyroid hormone causing an oversensitization of the thoracico-lumbar sympathetic system which over-rides the normal antagonistic moderator action of the parasympathetic.

2. The drive is present with varying intensity in the different portions of the sympathetic system and the relative preponderance of ocular, cardiac or gastric symtoms depends upon the degree to which the various parts of the sympathetic mechanism are affected by the altered thyroid secretion.

3. Interpreted in terms of the secretion of free hydrochloric acid the increased sympathetic drive causes a stimulation of the inhibitory acid-secreting fibres of the gastric mucosa and results in a diminution or lack of secretion of acid.

I wish to acknowledge with much appreciation the assistance of Mr. Delbert K. Judd, a senior student at the University of Nebraska, College of Medicine, who greatly aided in the preparation of this paper.

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CARDIAC ARREST

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There is perhaps no complication of the operating room that more nearly approaches tragedy than that of cardiac arrest. At once a smooth-working operating force may be thrown into a situation that borders on panic.

From the literature, one gathers evidence of the desperate efforts that have been brought forth to combat this unsuspected and unforeseen situation. In a small number of cases, a successful issue has been brought about, and, in a still larger number, life has been prolonged for hours with the heart restored to rhythmic contraction during that time.

It is likely that there are a large number of cases of cardiac arrest in which no effort at cardiac resuscitation has been attempted other than the use of stimulants, intracardiac and intravenously. However, these procedures are rarely successful if the circulation has ceased.

If the profession can be brought to the belief that no case of cardiac arrest has had every effort at life-saving exhausted, until direct cardiac massage has been done or the physiological resuscitation method of Crile resorted to, or both, I am sure we are going to have a greater number of successful cases reported.

In 1923, Borst [1] reported seventy-seven cases of cardiac arrest in which cardiac massage had been resorted to, with twenty successful issues. In 1924, Lee and Downs [2] added to this twenty-four more cases, making a total of 101, with twenty-five successful issues. In 1926, W. Girling Ball,[3] R. M. Glover [4] and Leo Doyle [5] each reported a successful case of cardiac massage. W. Stanfield [6] and L. Cook [7] reported cases of successful restoration of rhythm, but death a few hours later.

In the case of Ball, Glover and Doyle, it was possible to resume the operation after restoring cardiac rhythm.

. These reports alone should furnish sufficient stimulus to encourage renewed effort, not only in combating the condition, but in equipping the operating room for such an eventuality, since the time allowed for successfully putting into effort the necessary procedures for combating cardiac arrest does not admit of waiting. The equipment must be ready for immediate use.

The cardiac arrest in the operating room is either primarily cardiac or secondary to vaso-motor relaxation. In both types it is probably associated with ventricular fibrillation.

There has been a great decrease in cardiac death from ventricular fibrillation since the abandonment of chloroform. Cardiac failure secondary to vaso-motor relaxation may be foretold by repeated blood-pressure readings

during anæsthesia and often prevented by intravenous injections of fluid. Indeed, the blood-pressure may be maintained over a long period of time during an operation by the repeated injections of fluid, especially gum acacia solution (Adson and McIndoe, Surgical Clinics of North America, August, 1929).

Blood-pressure may fall fifteen or twenty points and remain so for some time before vaso-motor relaxation is clinically demonstrated. When it is manifested clinically, it appears with such suddenness that the heart is robbed of the essential fluid passing through it and fails suddenly.

It has been shown by Crile, Dolly, and Markowitz and Mann[8] (Surgical Clinics of North America, August, 1929) that if the pressure in the coronary arteries falls below 70 for a half-hour, the heart becomes arrested.

It has been demonstrated in animals with the heart removed from the body, that rhythm may be restored by the injection of fluids or air into the aorta in sufficient quantity to raise the pressure in the coronary vessels.

It has further been shown in experiments upon dogs that rhythm may be restored to the quiescent heart after a period of five or six minutes with the animal to all intent and purposes dead, by injecting into the left common carotid artery a solution of 1-50,000 adrenalin in normal saline (Crile, Markowitz[9] and Mann). This fluid finds its way into the aorta and ultimately into the coronary arteries. As soon as the intra-coronary pressure reaches a definite point, the cardiac rhythm is restored. If this be then followed by intravenous fluids, the vaso-motor tone may be restored and a benign circle established and the heart given an abundance of fluid upon which to work. If the heart remains quiescent, however, for more than six minutes, the animal may recover physical function, but is always damaged mentally, showing that the cerebral anæmia creates a more rapid degeneration in the cells of the cerebral cortex than it does in those of the medulla. It is at once apparent then that rhythm must be restored to a quiescent heart within a period of six minutes if we hope to restore the individual to complete normality.

Several methods for approaching the heart have been described. The one formerly used was the osteoplastic flap through the chest wall. Later an opening through the dipahragm large enough to admit the hand was advanced. Borst suggests an opening in the diaphragm near the costal border because of less likelihood of hæmorrhage and greater facility of closing such a wound. These transdiaphragmatic openings were undertaken with the hope of preventing lung collapse and pneumothorax, and are especially applicable to those cases occurring during abdominal operations where the abdomen is already open. The approach through the chest wall has the advantage of bringing the heart into sight and the oxygen pressure from the anæsthesizing machine will readily distend the lung after it has collapsed. By cutting through the costal cartilage, this flap of rib and soft part can be held aside with the retractor and thus give ready access for the hand and vision.

Respiration usually fails completely with cardiac arrest and may be

difficult to restore as it was in the report which follows. Indeed, Keen [10] makes the assertion that it is much easier to establish cardiac rhythm than to resuscitate the vaso-motor or respiratory centers. By keeping the lung distended with pure oxygen, it seems reasonable that sufficient oxygenation will take place until respiratory rhythm has been resumed. This was demonstrated in the successful case of W. Girling Ball (British Medical Journal, April 24, 1926).

It is extremely unlikely, with our present knowledge, that much success at restoration of rhythm can be expected in badly diseased hearts if quiescence has occurred. As a contribution to the literature of this subject I submit the following case report:

A colored woman, who gave her age as fifty-two years, was admitted to the service with senile gangrene of the right foot. The gangrene was of the dry type of four weeks' duration, preceded by periods of coldness and tingling in the foot. The line of demarcation was well defined. Urinary findings were negative, as were blood findings, except for slight leucocytosis. There was a marked general arteriosclerosis. The heart was normal in size with well-defined rhythm and normal sounds. The blood-pressure on the table before operation was $\frac{140}{80}$ $\frac{\text{systolic}}{\text{diastolic}}$ as had been determined previously. Amputation of the limb at the point of election, under light anæsthesia, was determined upon.

Operation.—The limb was prepared for amputation and nitrous-oxide anæsthesia begun. After a few deep inhalations the respiration became labored and suddenly ceased. It was not resumed after a few efforts of artificial respiration. No pulse was evident and no heart beat could be determined with the stethoscope and no blood-pressure registering. An intracardiac injection of fifteen minims of adrenalin, 1-1000 was given, and the thorax slapped and compressed over the heart without avail. An intravenous injection of 1-50,000 adrenalin in normal saline in the left common carotid artery was immediately started and 200 c.c. of this fluid allowed to run into the aorta. The heart was still quiescent; no respiratory function and no blood-pressure recorded.

An incision through the soft parts and costal cartilage from the third and seventh ribs was quickly done, but with no attempts at osteoplastic flap. This incision could be retracted so as to permit insertion of the hand as well as give good vision, the left lung having immediately collapsed. The heart was quiescent and distended. On the third effort at emptying, the rhythm was restored with force and regularity and a blood-pressure recorded of 140/90.

However, no respiratory effort was maintained. The incision through the chest wall was closed and the lungs distended with CO_2, both readily filling. The lungs were allowed to empty and were then refilled with CO_2. This was repeated several times, without any effort at restoring the respiratory function. The heart began to fail again and finally became quiescent for a second time.

The chest wound was hurriedly reopened and massage begun again. Again the heart responded but with a great deal of fibrillation. The maximum dose (130 minims) of digifolin was now injected directly into the left ventricle with definite improvement of rhythm and cessation finally of fibrillation. It was felt that there was some connection between the administration of CO_2 and the second period of quiescence. After closing the chest a second time the lungs were distended with oxygen and kept so for nearly five hours following. At intervals of ten minutes the lungs were allowed to gradually empty themselves of oxygen and were then refilled. Apparently sufficient oxygen was obtained since there was no evidence of cyanosis and the blood looked to be of good red color.

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During the five-hour period of no respiratory effort the heart rhythm was good and systolic blood-pressure maintained at 180. Each time the lungs were allowed to empty and effort at manipulating the epiglottis and arytenoids with the finger was done. I was finally successful in restoring continuous respiratory function after a five-hour period of cessation. The rate was first eight per minute, increasing to twelve, then sixteen, and, finally, twenty per minute one hour after its reëstablishment.

The patient went on then for three hours with good cardiac rhythm, blood-pressure 180/90 and deep, full respiratory efforts at twenty per minute. Pulse rate 110. At the end of this time the blood-pressure began to fall and intravenous fluid (6 per cent gum acacia in normal saline) was given slowly with the hope of combating vaso-motor relaxation. However, the pulse rate gradually increased with blood-pressure falling and respiration becoming more and more shallow until there was complete failure of heart-beat and respiration one hour later.

The length of time that elapsed from the first period of quiescence to the ultimate failure was a little over nine hours. The first period of quiescent heart lasted six minutes, the second three minutes. In the interval between these two periods good rhythm was maintained for ten minutes. For five hours there was no voluntary respiratory effort. The patient never reacted or showed any consciousness or made any movement during this nine-hour period, although good heart rhythm, good respiratory rhythm and good blood-pressure were maintained.

In the face of advanced arterial disease it was felt that this was a most unfavorable case for good ultimate result. It is probably that the cortical and medullary centers were too badly damaged by the anæmia attendant upon the quiescent heart to admit of complete recovery.

COMMENTS

1. The occurrence of cardiac arrest is perhaps more frequent than we are inclined to think. It may be the cause of death in a large majority of the cases that occur on the operating table, whether it be primarily a cardiac failure or cardiac failure secondary to vaso-motor relaxation.

2. Primary cardiac arrest can be combated successfully by cardiac massage. Cardiac arrest secondary to vaso-motor relaxation can be prevented by preserving the vaso-motor tone during the operation and combated by raising the intra-coronary tone through intra-arterial injections of fluid followed by intravenous injections of fluid. In this type of arrest direct cardiac massage may also be of great value. The success of the issue depends, to a large extent, on the preparedness of the operating room to combat such an eventuality.

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CHORDOTOMY FOR INTRACTABLE PELVIC PAIN

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Most of modern surgery is confined to the performance of procedures that might be classified as curative in nature, while those operations that might be classified as palliative occupy a rather insignificant place. This probably is as it should be because palliative surgery, in general, is somewhat disappointing. Of such palliative operations we might refer to that of gastrostomy for the relief of cancer of the œsophagus, an operation that may restore the former nutritional condition but also subjects the patient to the repeated suffering of an exitus delayed only by a period of months. It undoubtedly is more beneficent therapy to let this unfortunate condition destroy itself straightway rather than to perform the palliative gastrostomy. The same statement applies to the operation of gastroenterostomy in the cachectic patient suffering from carcinoma of the pylorus. Similarly, the suprapubic cystostomy for irremovable cancer of the prostate is of questionable benefit and likewise the palliative decompression for extensive gliomas of the brain frequently carries little to commend it. Operations for the relief of pain, however, stand in an altogether different category from those referred to above. The division of the sensory root of the trigeminal nerve for neuralgia is one of the great accomplishments in surgical therapy as is also the operation of chordotomy. The latter operation was carried out in the case which is the subject of the present report.

Case.—A white man, forty-nine years old, was admitted to the Lakeside Hospital, February 8, 1930, complaining of pain in the pelvis and the lower abdomen on the left side. The family history contained nothing noteworthy. The patient had poliomyelitis at the age of three years, leaving him with a residual paralysis and atrophy of the right leg. Since this illness, he has walked with a crutch. He had typhoid fever in 1904 and an appendectomy for acute appendicitis in 1924. He worked in a machine shop and in spite of the paralysis and atrophy of the right leg, was able to do manual work. January 16, 1928, a heavy lathe impinged him upon a cement floor, compressing the pelvis and lower abdomen. He was brought to the Lakeside Hospital in a condition of serious shock. He had sustained a crushed pelvis and a rupture of the bladder. A transfusion of 500 cubic centimetres of blood was given and the rupture of the bladder was repaired. The X-ray of the pelvis showed the left ilium, both ischia and the left pubis, to be fractured. There were several small particles of bone lying near the left sacro-iliac joint, although the joint itself seemed to be in fair alignment. The left transverse process of the fifth lumbar vertebra was fractured. Throughout the period of convalescence in the hospital, the patient suffered considerable pain in the region of the fractures. A brace for the back and pelvis was procured and the patient later became ambulatory with two crutches. The pain was of a dull, boring, constant nature. He was discharged March 29, 1928.

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In February, 1929, the patient developed an ischio rectal abscess which was opened and drained at this hospital. Subsequently, this drainage tract closed.

The patient has been totally unable to work. On February 8, 1930, the severity and the chronicity of his pain forced the patient to reënter the hospital for its relief. The pain was localized almost entirely between the costal margin on the left and the lower part of the pelvis. What discomfort existed on the right side of the pelvis was very slight. The pain was constant both day and night. Except for the pain and the atrophy of the right leg, the general condition was good. In view of the fact that the pain was localized almost entirely to the left side, it was thought that section of the pain fibres on the right side of the cord would give relief. The operation was explained to the patient—that he would lose the sensation of pin-point pain and the sensation of heat and cold on the left side. The patient readily accepted operation.

Accordingly, on Febuary 17, under novocaine anæsthesia, laminectomy was carried out over the fourth, fifth, and sixth thoracic vertebræ. The dentate ligament on the right side of the spinal cord was picked up in a small clamp and the cord rotated to the opposite side. This exposed the anterolateral tract on the right side. The point of a scalpel was inserted just anterior to the dental ligament to a depth of 3.5 millimetres and carried forward for about the same distance. The area of anæsthesia on the left side of the body was then determined and it was found to be adequate. The operative wound was sutured. The patient immediately felt relieved of the former pain.

The convalescence was uneventful and the patient was discharged from the hospital March 19, 1930. The area rendered anæsthetic to pin-point pain extended from the costal margin on the left downward over the pelvis and left leg. The sensation of heat and cold was lost over this area. The sensation of light touch was preserved. The reflexes were normal. The sense of position and the vibratory sense were normal. There was no motor involvement; and there was no difficulty in urination.

The patient was last seen April 4, 1930, at which time he was delighted with the result. The operation has given him the only freedom of pain since the accident, two years ago. He sleeps the whole night and he walks with much greater freedom than he did. The patient believes he will be able to get back to work. A few days ago a kitten ran up the left leg and the patient was unaware of it. He has paradoxical heat and cold sensations.

Discussion of the Operation.—The localization in the spinal cord of the conduction pathway for pain was suggested by Gowers in 1879 and by Van Gehuchten in 1893. That the sensations of pain and temperature passed up the cord in Gowers' tract had no positive proof in man, however, until a brilliant observation was made by Spiller[1] in 1905. This observation was a correlation between a clinical condition consisting of the loss of sensation for pain and temperature in the legs with the preservation of tactile sensibility, and the pathological condition of a solitary tubercle located in each tract of Gowers at the level of the lower thoracic cord. In this tract were accurately localized, therefore, the pathways for pain and temperature. It contained no motor fibres and no other important sensory fibres. That it could be sectioned for the relief of intractable pain was proposed by Schüller[2] in 1910 and by Spiller[3] in 1911.

The first chordotomy was performed by Spiller and Martin[3] in 1911 and the second by Beer[4] in 1912. Later, the operation was performed by Tietze[5] and by Elsberg,[6] and in 1920 a series of six cases was published by Frazier.[7] Subsequently, a number of reports on the subject appeared by Leighton,[8] Frazier and Spiller,[9] Peet,[10] Foerster,[11] Sicard and Robineau,[12] Sicard,

Haguenau and Wallich,[13] Robineau and Banzet,[14] Aievoli,[15] Horrax,[16] and Beck.[17] Within recent years the operation has gained favor.

The operation is not difficult to perform, although the section of the anterolateral columns must be done with accuracy and precision. The level for the laminectomy varies with the case. The section of the fibres should be at least four or five segments above the area to be rendered analgesic. As a general rule, the division is carried out at the level of the fourth, fifth, or sixth thoracic vertebra. For upper abdominal pain, Peet[10] advises division of the posterior nerve roots together with chordotomy.

Two or three posterior spinous processes are removed together with their laminæ. The dura is opened throughout the length of the incision. The arachnoid is identified laterally on each side to its attachment with the cord at the dentate ligament. The latter structure is an important landmark and lies between the anterior and posterior nerve roots. The arachnoid is opened along the mid-line posteriorly. Retraction of the arachnoid exposes the dentate ligament and the posterior roots. The dentate ligament is grasped in a small clamp. (Fig. 1.) Gentle traction upon the dentate ligament rotates the cord and exposes the anterolateral column. It is this column that carries contralateral pain and temperature fibres. These fibres lie in the area between the dentate ligament and the line marking the emergence of the anterior roots from the cord and extends to a depth of three and one-half millimetres.

It is important that at the level of the emergence of the anterior root the incision should be at a depth of three millimetres. To carry out the section of these fibres a slender tenotome knife is satisfactory. One should mark the blade three or three and one-half millimetres from the point. The knife is then inserted into the cord at the dentate ligament to the mark on the blade and carried forward to emerge

Fig. 1.—Laminectomy was performed at the level of the fourth, fifth and sixth thoracic vertebræ. The clamp placed on the dentate ligament rotates the cord to the left. The point of the knife is inserted 3.5 millimetres at the attachment of the dentate ligament and carried anteriorly to the point of emergence of the motor nerve root.

at the exit of an anterior root. (Fig. 2.) If bilateral chordotomy is indicated, the procedure is carried out in the same way on the opposite side.

Following division of the anterolateral tracts, there should be complete loss of pain and temperature sense on the opposite side, depending upon the level and depth of section. If the section be carried to an insufficient depth, the area of analgesia may be much lower and incomplete. This may necessitate a repeated operation. The motor function is not impaired. Tactile, vibratory and postural perceptions are not impaired. The reflexes are preserved.

Since the fibres entering the cord ascend several segments before they cross to the contralateral side, the operation must be performed several segments above the segment level of the pain. The highest level at which section of the anterolateral column could be made without involving the phrenic nerve is at the level of the sixth cervical segment. From this consideration alone, the application of this operation is limited to those conditions in which there is pain below the third thoracic segment. This area includes the trunk, pelvis and legs. In those cases in which pain is present in the pelvis and legs, the level for the chordotomy is determined where it is most conveniently carried out at operation; namely, the mid-thoracic region.

We recommend the operation for relief of any form of intractable pain in the abdomen, pelvis or legs. It is preferable to rhizotomy, an operation consisting of the section of the posterior nerve roots. Rhizotomy not infrequently fails to give complete relief and its failure is usually due to the fact that the nerve roots cannot be sectioned over a sufficiently wide area.

FIG. 2.—Cross section of the cord showing the anterolateral column in relating to the dentate ligament and the posterior and anterior nerve roots.

Chordotomy can be carried out without sacrificing any motor fibres or any other important sensory fibres except those of temperature. The conditions for which the operation has been carried out are as follows: malignant disease primary in the spine, gunshot injury of the spine, tabes dorsalis, carcinoma of the rectum, myelitis, carcinoma of the cæcum, carcinoma of the uterus, carcinoma of the prostate, carcinoma of the breast, carcinoma of the lung, retroperitoneal malignancy, sarcoma of the thigh, shell wound of the sciatic nerve in the pelvis, pain in the vagina and rectum of unknown origin, pain of unknown etiology in the legs associated with spasmodic contractions, and avulsions of of the lumbosacral plexus. The cases of malignancy had metastases to the spine, pelvis, or pelvic glands with involvement of the lumbosacral plexus.

In one of our cases in which the bilateral section was carried out, dribbling at urination occurred. When the bilateral operation is carried out we advise the section of the tract to be made not deeper than three millimetres on each side. If the operation be carried out under local anæsthesia, the section of the tract can be repeated to obtain the desired height. Of the nineteen cases reported by Peet,[10] complete relief of pain was obtained in sixteen, partial relief in two, and complete but apparently temporary relief in one.

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THE MORTALITY AND LATE RESULTS OF SUBTOTAL GASTRECTOMY FOR THE RADICAL CURE OF GASTRIC AND DUODENAL ULCER*

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SURGEON TO MT. SINAI HOSPITAL

It is well, at the very outset of this paper, to state emphatically that ulcer of the stomach is the same disease as ulcer of the duodenum. So far as we know, an ulcer situated in either viscus depends upon the same causes for its formation, has the same life history, is amenable to the same methods of treatment, and in the chronic stages can be radically cured in only one way, and that is by surgical operative methods. This statement is made because it has become the practice of a good many internists and surgeons to deal with ulcer of the stomach as though it were an entirely different disease from ulcer of the duodenum. Thus, for example, a great many surgeons advise and carry out a subtotal gastrectomy for the radical cure of gastric ulcer but strongly object to this operation for the radical cure of duodenal ulcer. Such surgeons are perfectly willing to resort to deforming and mutilating operations upon the stomach to get rid of a gastric ulcer but they are unwilling to employ such mutilating and deforming operations on the stomach for the radical cure of duodenal ulcer. It would seem logical that if a particular kind of operation is used to bring about a cure in gastric ulcer the same kind of operation should be employed to bring about this result in a similar disease when it is situated in the duodenum.

In previous communications I have dwelt in detail upon our conception of what is necessary for the formation and development of a gastric or duodenal ulcer. According to our idea there are three important factors concerned in the formation and development of such an ulcer. These factors are the existence of a *specific ulcer gastritis, the presence of free hydrochloric acid in the stomach*, and *the presence of a secondary infection in the stomach or duodenum*, usually with the green streptococcus. All three of these factors must be in evidence. As regards the specific ulcer gastritis, the writer is well aware that some eminent pathologists consider that the gastritis is attendant upon and due to the ulcer and not one of the underlying conditions of ulcer formation. It must be conceded by them, however, that a specific ulcer gastritis may exist before an indurated ulcer developes, but with every ulcer a more or less extensive specific gastritis is present. A tendency to develop a chronic specific ulcer gastritis may be inherited or it may be acquired. It is well known, for example, that ulcer of the stomach or duodenum frequently occurs in several members of a family and is more

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prone to occur in individuals of a particular physical character. On the other hand, it is equally well known that the tendency to the formation of a chronic ulcer gastritis occurs after severe pestilence, after exhaustive disease, after war, and other forms of physical and nervous shock.

The symptoms of *chronic ulcer gastritis* may be present for a long time before the actual formation of ulcer. These symptoms are of the same character as those of ulcer. This explains why, in some patients who have a typical ulcer history, no ulcer is found at operation, or at the autopsy table. A patient with a chronic specific ulcer gastritis sooner or later develops an ulcer if the gastric contents are acid and a secondary infection is present. In the early stages of a specific ulcer gastritis medical treatment can influ-

Fig. 1.—Partial gastrectomy for duodenal ulcer. Note the *extensive polypoid* gastritis in the whole of the antrum, which precedes the development of gastric and duodenal ulcer.

ence those factors which cause it to persist but when the ulcer is fully developed and has persisted for a number of months prior to the employment of medical treatment, then dietary and medical means can usually only alleviate and rarely bring about a permanent and radical cure. We are accustomed to define an ulcer of the stomach or duodenum as an *infected abrasion* resulting from a specific gastritis in the presence of free hydrochloric acid.

It must be clearly understood that in our clinic, operation for ulcer of the stomach and duodenum is undertaken only after repeated failures of medical treatment to cure. The patient with ulcer of the stomach or duodenum is always referred to the internist for one or more dietary and medicinal treatments and only when these fail to cure or alleviate is operation advised. Of course, sudden perforation is treated at once by operation and the individuals who have cicatricial stenoses and deformities of the stomach as a

result of an ulcer have had the benefit of medical treatment prior to the time they come to us.

Up to 1920, we followed, in our clinic, the customary methods of treatment for the cure of gastric and duodenal ulcer. We employed, at various times, the operations of gastroenterostomy, ulcer excision, cautery puncture, and pyloroplasty. These operative procedures did not give us satisfactory *late results*. We found, in our follow-up of these patients, that only about 50 per cent. were cured and that at least 30 per cent. developed new ulcers at the gastroenteric stoma or had recurrent ulcers at the site of the original lesion. These results were published by my colleague, Doctor Lewisohn. They were substantiated by the results of a number of continental surgeons, notably Bier, Payr, Von Haberer, and others. We found, in our follow-up investigations (and this should be continued for ten years), that patients who had been subjected to one or the other of these operations were frequently much worse off than they had been before operation. Their sufferings were much more severe, and, whereas before these operations had been performed they had obtained some relief from medical treatment, no such relief was obtainable from diet and medication when new ulcers formed at the new stoma or recurrent ulcers developed at the site of excision or pyloroplasty.

The disappointing late results of these operations and the equally disappointing late results of medical treatment led us to seek for new methods that would afford a lasting cure. If our conception of the factors concerned in the development of an ulcer was basically true, then any operation which was to be applied for the lasting cure of gastric or duodenal ulcer would, of necessity, have to remove these factors; namely, it would have to remove the chronic specific gastritis, it would have to render the stomach anacid, and it would have to do away with the secondary infection. The procedure that would most nearly satisfy these conditions was a partial or subtotal gastrectomy.

We had sporadically performed partial gastrectomy for gastric and duodenal ulcer since 1900 and we were impressed by the fact that patients who had been subjected to a partial gastrectomy were cured of their disease. In Germany and Austria this operation was gaining markedly in favor, especially by Von Haberer and Finsterer, and we determined to employ this operation as routine procedure for the cure of gastric and duodenal ulcer. We came to this decision in 1920.

At that time there was no standardized plan of carrying out this operation. The operation, of course, is to be divided into two parts: *first, the removal of the antrum and part of the body of the stomach, together with the pylorus and affected portion of the duodenum;* and, *secondly, the reëstablishment of the connection between the stomach and the duodenum or jejunum.* The first part of this procedure had been approached in different ways by different operators. Some advised removing the first portion of the duodenum, pylorus, antrum, and portion of the body of the stomach in a

retrograde fashion; that is, from the duodenum towards the upper end of the stomach. Others recommended commencing at the upper end of the stomach and removing the same parts from above downward. Some opened the duodenum and with the finger inside its lumen peeled out the perforated, adherent, ulcerated portion of this viscus from the head of the pancreas and neighboring structures. The points of danger in the removal of this portion of the stomach and duodenum were not known or dwelt upon. It was necessary, therefore, to establish a definite method of procedure that would have in view a safe and speedy removal of the portion of the stomach, pylorus, and duodenum.

As regards the second part of the operation, *viz.*, the reëstablishment of the gastroenteric circulation, here again various operators followed different methods of procedure. Von Haberer used the method of Billroth No. 1; namely, end-to-end gastroduodenostomy, and he reported good results therewith. Later on, he found that this method was not applicable to all cases of duodenal ulcer because frequently the ulcer was situated below the normal peritoneal investment of the duodenum. In such cases he used gastroduodenostomy, end-to-side, implanting the cut end of the stomach into the side of the duodenum. Finsterer, on the other hand, was using the method of Billroth No. 2 with gastrojejunostomy. Some operators were making a gastrojejunal ante-colic (long loop) anastomosis, while some made it retrocolic with no loop. Some combined jejuno-jejunal anastomosis with a gastrojejunal implantation. Some operators used Murphy buttons for the anastomosis.

With an open mind we approached the subject of how to reëstablish the gastroenteric circulation. In 1921, 1922, and part of 1923 we used successively the various methods of gastroduodenal and gastrojejunal anastomosis. We were not at all satisfied with the results of the Billroth No. 1 or of the Billroth No. 2 either as regards motility of the stump of the stomach or as regards the applicability of the Billroth No. 1 to deep penetrating ulcers of the duodenum. We employed each one of these methods of anastomosis in a number of cases and observed the results both as regards motility and function of the stomach. The Murphy button was the least satisfactory. Though, by its use, ten to fifteen minutes of time were saved, and though it could be employed in cases where the ulcers were situated high at the cardia and the usual suture methods of anastomosis were entirely non-applicable, still, its routine use was not attended with satisfactory results. The lumen of the button would often become closed by gastric secretions or by a little blood; patients would vomit and it seemed as though post-operative pneumonia was more common with this than with the other methods of anastomosis. Thus we went from one type of anastomosis to another until, in November, 1923, we independently devised the method of gastrojejunal implantation which we subsequently found had been described and pictured by Kronlein and Hofmeister. Almost from the first the procedure gave us very satisfactory results and from November, 1923, we adopted it as routine

anastomosis between the stump of the stomach and the first portion of the jejunum. The entire operation—removal of a portion of the body, antrum, pylorus, and affected portion of the duodenum—and the method of reëstab-
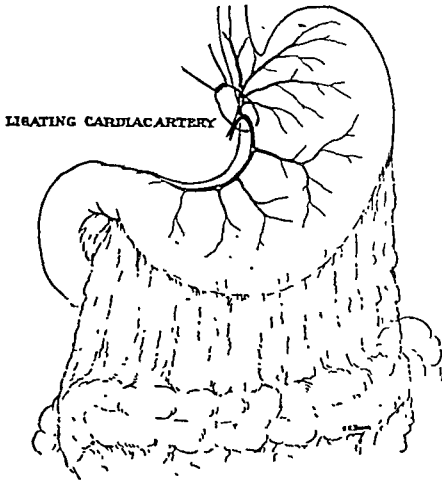
FIG. 2.—First step in partial gastrectomy is ligation of the cardiac artery two inches above the incisura angularis.
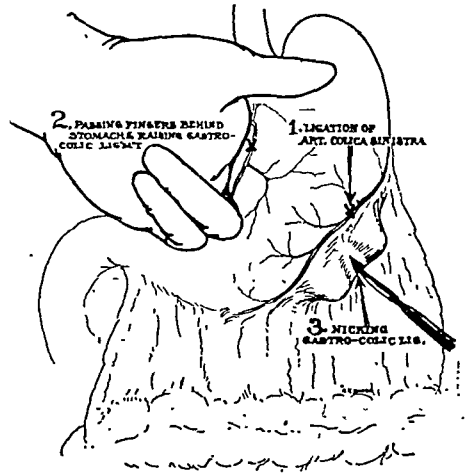
FIG. 3.—The index and middle fingers break through the gastro-hepatic omentum, pass behind the stomach and put the gastro-colic ligament on the stretch. The latter is incised at a point directly opposite to the site of ligation of the cardiac artery and the left gastro-colic artery is clamped and divided.

lishing the anastomosis between the stomach and jejunum, according to the descriptions of Hofmeister, were published by me in the Surgical Clinics, in 1925. I am illustrating this procedure again. This method of removing an
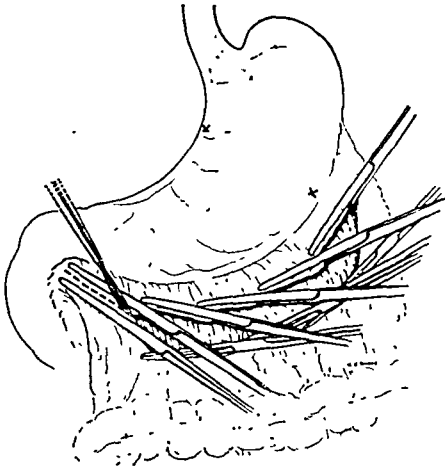
FIG. 4.—The gastro-colic ligament is divided between clamps, below the arch of the gastro-colic arteries. During this procedure the upper layer of the transverse meso-colon is carefully pushed away from the posterior wall of the stomach, so as to avoid the middle colic artery.
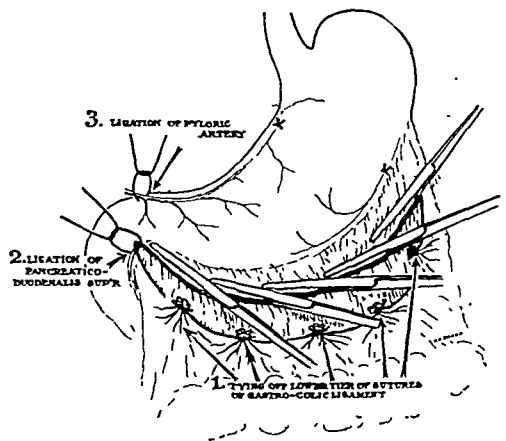
FIG. 5.—The pyloric artery is clamped just beyond the pylorus, divided and ligated.

ulcer in the stomach or duodenum is simple and when one has acquired dexterity it can be rapidly and accurately accomplished.

We have adopted it as a routine procedure and as a standardized opera-
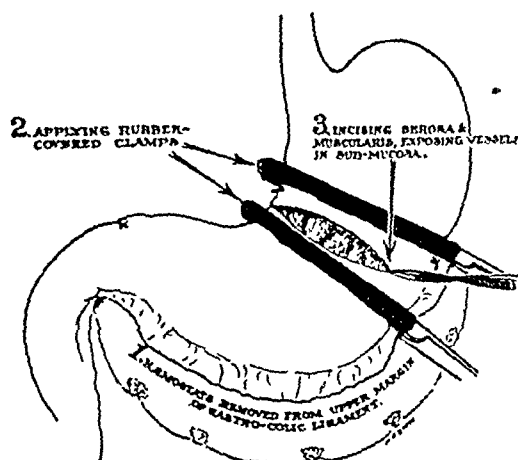
FIG. 6.—The arterial supply of the portion of the stomach to be removed, the pylorus and first portion of the duodenum has been ligated, and two long straight clamps are applied to the stomach. The stomach wall is to be divided between the clamps.
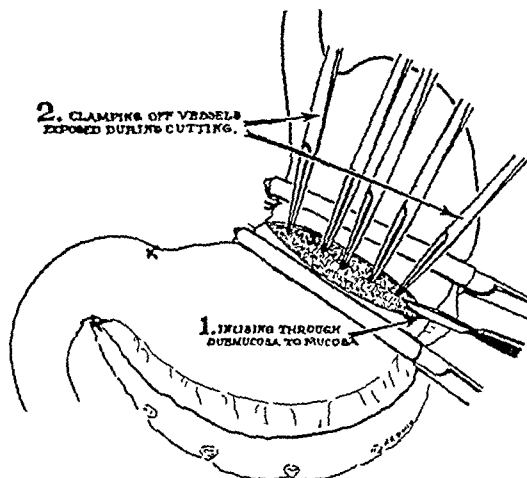
FIG. 7.—The serosa and muscularis of the gastric wall are cut through, thus exposing the intrinsic gastric vessels, which are caught with small clamps, divided and ligated.
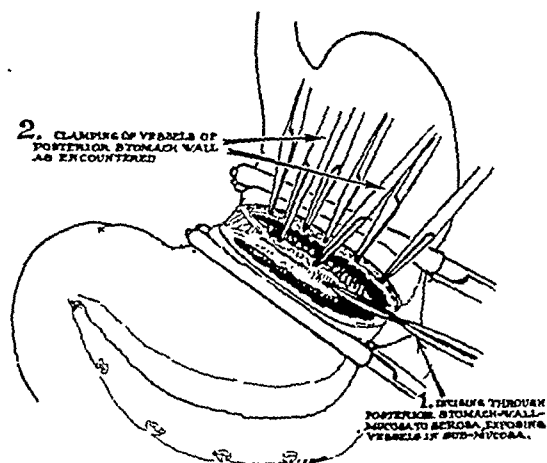
FIG. 8.—On the posterior gastric wall the mucous membrane is divided first and the intrinsic gastric vessels caught and ligated.
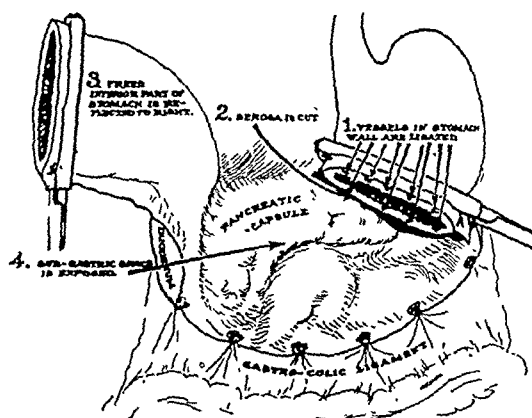
FIG. 9.—The distal stump of the stomach is covered with a pad and turned to the right, thus exposing the head of the pancreas, the peritoneal reflection of the meso-colon on to the posterior. duodenal wall, and the posterior duodenal wall. The proximal gastric stump is covered with a pad.
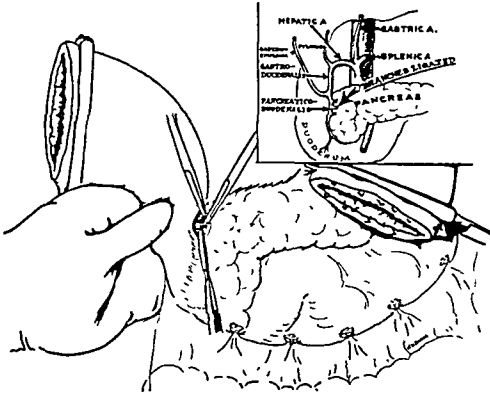
FIG. 10.—Dividing the peritoneal reflection onto the posterior duodenal wall, so as to separate the duodenum from the pancreas. It is important to keep outside the capsule of the pancreas. During this separation several branches of the pancreatico-duodenal artery are usually divided. They must be carefully clamped and ligated.
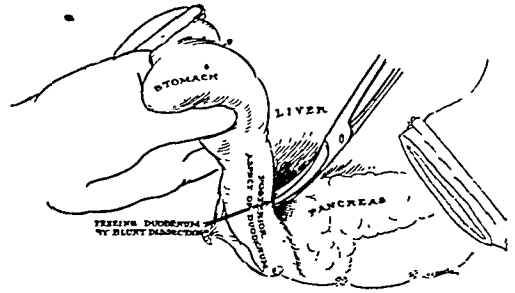
FIG. 11.—Freeing the duodenum from the pancreas either by blunt dissection or with sharp knife. Care must be taken to keep outside of the capsule of the pancreas.
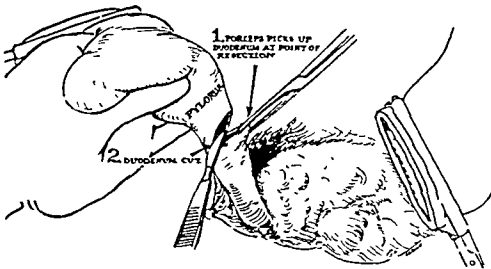
FIG. 12.—Cutting across the duodenum *without* the use of clamps below the ulcers. The absence of clamps enables the operator to look into and palpate the duodenum.
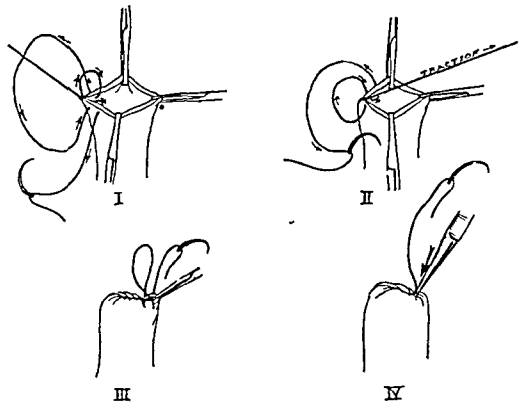
FIG. 13.—Closure of the duodenal stump by two layers of sutures. First layer is a through and through suture of catgut, passed mattress fashion, from without inward. The mucous membrane must be carefully turned in.

tion. As shown in the illustrations, the operation commences at a definite point (the ligation of the cardiac artery) and proceeds from that point straight ahead in successive stages until the desired portion of the stomach
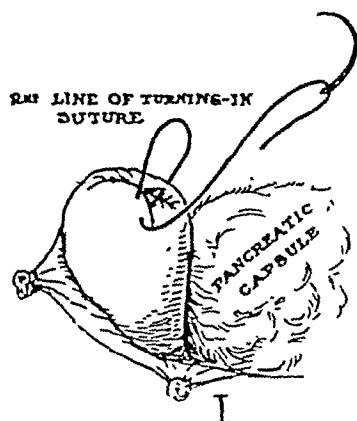
FIG. 14.—I. The second layer of sutures is of catgut or linen passed in purse-string or mattress fashion.
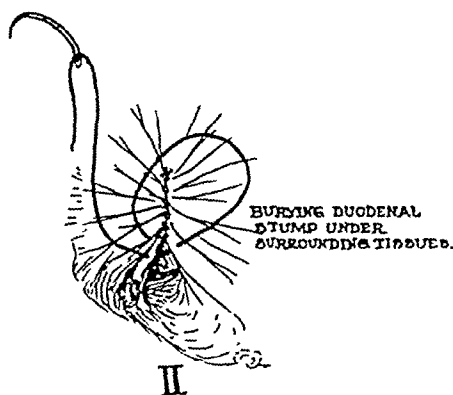
FIG. 15.—II. The duodenal stump is peritonealized by sewing the peritoneum of the transverse meso-colon over to the anterior duodenal wall.

and duodenum has been removed and then a gastrojejunal anastomosis is established according to the method of Hofmeister. This routine, standardized procedure is deviated from only when local conditions demand it. There are a number of "don'ts" that must be strictly observed. First, and principally, too much stress cannot be laid upon avoiding entrance within the pancreatic capsule while mobilizing the duodenum. Such an act opens the door to infection of the pancreas and its consequent evil, frequently fatal, results. Ulcers that penetrate within the capsule of the pancreas are usually surrounded by an inflammatory wall and it is highly important to keep inside the limits of this inflammatory wall. Again the bed of an ulcer, penetrating on or into the head of the pancreas, must be well cleaned with iodine. Espe-

FIG. 16.—The first step in establishing the gastro-jejunal anastomosis, according to the method of Hofmeister, is to incise the transverse mesocolon in a vascular free portion.

cially important is it to avoid any hematoma around the head of the pancreas or around the duodenal stump. Such hematomata frequently become infected and thus occasion pancreatitis, peritonitis, duodenal fistulæ, *etc.* Finally, it is very important to cover over all the raw areas left in the dissection by sewing the upper layer of the transverse meso-colon to the anterior wall of the duodenum so as to prevent accumulation of secretions in these raw spaces. Such secretions easily become infected and, in their turn, give rise to peritonitis, fistulæ, etc.

I

COLON REFLECTED UPWARD,
LOOP OF JEJUNUM PUSHED
INTO MESO-COLIC INCISION.

II

JEJUNUM

COLON & MESO-COLON IN
NORMAL POSITION, LOOP
OF JEJUNUM IN APPOSITION
TO STOMACH.

III

JEJUNUM

LOWER END OF STOMACH
.TURNED UP; UPPER EDGE OF
MESO-COLIC INCISION
SUTURED TO POSTERIOR
WALL OF STOMACH.
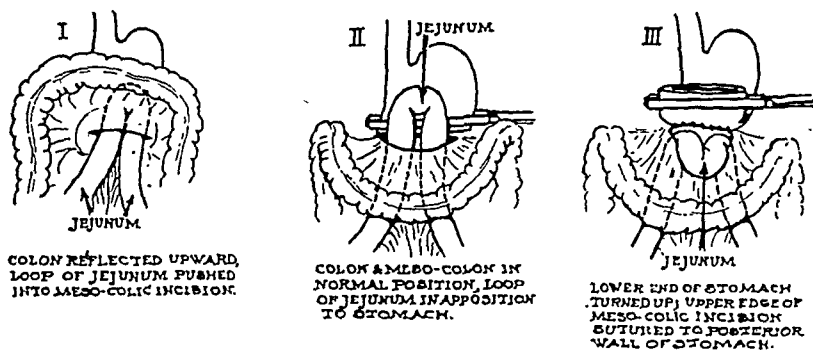
FIG. 17.—A loop of the jejunum just below the fossa of Treitz is drawn up through the opening made in the transverse mesocolon and a part thereof that will ride easily when attached to the cut end of the stomach (without a loop between this part, and the fossa of Treitz similar to a no loop posterior gastro-enterostomy) is grasped in a long, straight, intestinal clamp. The one edge of the opening made in the transverse mesocolon is attached by a few sutures to the posterior wall of the stomach (Fig. III).

CLAMP APPLIED TO
JEJUNAL LOOP

FIG. 18.

2. PERITONEAL SUTURE;
JEJUNUM TO POST'R
SURFACE OF STOMACH

1 CLAMPED-OFF PORTION
OF JEJUNUM APPROXIMATED
TO POST'R SIDE OF STOMACH-STUMP.
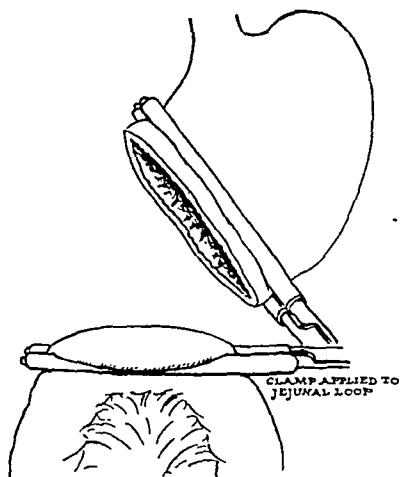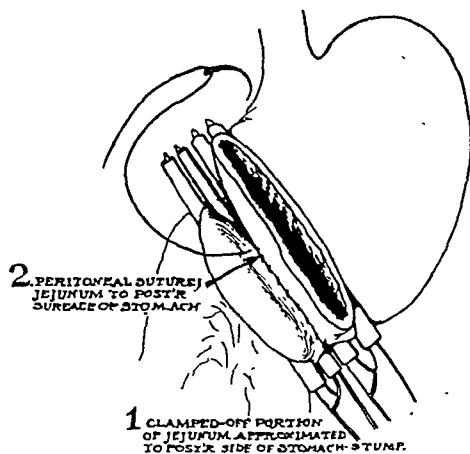
FIG. 19.

The clamp on the stump of the stomach is approximated to the clamp on the jejunum and an implantation of the cut end of the stomach into the jejunum is made in the typical way.

The closure of the duodenum must be done with meticulous care. The first layer of sutures is a through-and-through mattress one, passed from without in, and *the mucous membrane must be carefully turned in at all points*. The second layer of sutures may be passed either in purse-string
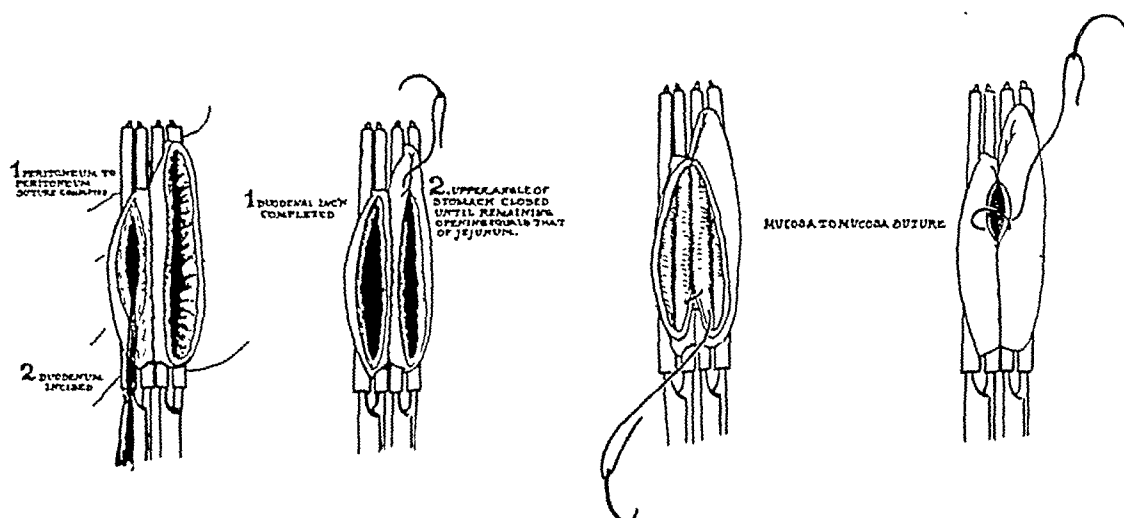
FIG. 20.—Implantation of the cut end of the stomach into the jejunum by two layers of sutures, an inner of catgut and an outer serosal suture of catgut or linen.

fashion, where there is enough peritoneal surface of the duodenum left behind, or the capsule of the pancreas is sewn over to the anterior duodenal wall, thus buttressing the first layer of sutures with the head of the pancreas. If the duodenal suture is carefully carried out, no duodenal fistulæ will result.

Care must be taken not to injure the middle colic artery. This accident can be avoided if the transverse mesocolon is separated from the posterior wall of the stomach before any clamps are applied.

The avoidance of hæmorrhage from the cut end of the stomach can be accomplished *in only one way*; namely, by grasping the blood-vessels in the wall of the stomach individually and separately, and tying each one of such vessels. Post-operative bleeding into the stomach may be immediately fatal

FIG. 21.—Replacement of the jejunum and the anastomosis below the transverse meso-colon and attaching the other edge of the opening in the transverse meso-colon to the anterior wall of the stomach.

or it may favor a fatal issue by aspiration of blood into the lungs during vomiting or by materially reducing the resisting power of the individual.

As has been said above, we have followed this standardized routine procedure from November, 1923, and it is to the results obtained in the use of this operation for the radical cure of gastric and duodenal ulcer that I invite your attention. In the first place, to the *immediate operative mortality*. It is important to state at this point that at Mount Sinai Hospital, where the cases reported in this paper were done, we recognize no difference between

hospital mortality and operative mortality. The patient is discharged from Mount Sinai well or dead. It is utterly immaterial how long the patient stays in the hospital. If he dies weeks or months after the operation the death is recorded as an operative death and all these statistics must be viewed in that light.

Total number of primary and secondary operations for ulcer of stomach and duodenum and gastrojejunal and jejunal ulcers:

Ward Service, December, 1923–December, 1929	{ Primary operations .... 233 { Secondary operations 81
Private Service, January, 1924–December, 1928	{ Primary operations .... 178 { Secondary operations 24

516

Total number of *primary operations* for ulcer of stomach and duodenum, 411
Of these
Six were at cardia or juxta-cardia
405 were in the stomach below cardia or in the duodenum

Total number of *secondary operations* for recurrent gastric and duodenal ulcers and gastrojejunal and jejunal ulcers, 105
Mortality in primary subtotal gastrectomy
Total number of cases 405
Total number of deaths 32

7.9 per cent.

Properly exclude from this operative mortality:
1 death—puncture of lung by interne during subcutaneous saline infusion
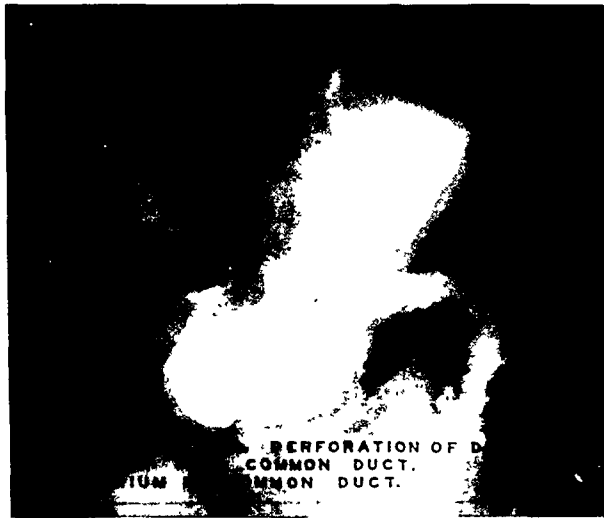
FIG. 22.—The white lines in the liver easily seen with a hand lens indicate the barium in the liver ducts, after a barium test meal.

1 death from transverse myelitis. (Six weeks after operation autopsy showed abdominal viscera entirely healthy)
1 death—pathological, pre-operative, duodeno-choledochal fistula with cholangitis
1 death—patient with *active tuberculosis* in whom operation had been repeatedly rejected by surgeon.

Thus leaving

Total of cases 401
Total deaths 28

6.9 per cent. mortality

This mortality includes every death following primary subtotal gastrectomy during six years of ward and five years of private service.

It includes all bleeding ulcers, active or arrested
all patients with chronic pulmonary lesions
all patients with chronic cardiovascular disease
all patients with tetany
all patients with chronic renal lesions.

It is proper at this point to define what we mean by a *primary* and *secondary partial gastrectomy*. By a *primary subtotal* or *partial gastrectomy* we mean that the patient has had *no previous major gastric operation* done prior to the subtotal gastrectomy. He may have had an exploratory laparotomy, or an appendectomy, or cholecystectomy, or an exploratory gastrostomy, but we mean that there has not been a preceding gastroenterostomy, pyloric excision, pyloroplasty, or closure of a perforated duodenal or gastric ulcer. By a *secondary operation we mean that the patient has had one or more* (in our series the maximum number of preceding operations was fourteen) preceding major gastric operations such as gastroenterostomy, pyloroplasty, ulcer excision, *etc.* The reason for this differentiation is that "preceding major gastric operations" usually result in the formation of more or less dense adhesions between the stomach, omentum, liver, gall-bladder, pancreas, and abdominal wall. The division of such adhesions and the development of the stomach are usually severe operations and contribute materially to shock and post-operative sequellæ. This can be seen when we study the mortality statistics in primary subtotal gastrectomy and in secondary subtotal gastrectomy. In the former, in our own series, the operative mortality has been 6.9 per cent., whereas in the secondary operations the mortality has been 20.9 per cent.

It is of importance to compare the immediate operative results of primary partial gastrectomy with those of gastroenterostomy, *etc.* In a recent publication of the Mayo Clinic (vol. V, No. 9), Doctor Balfour reports the mortality of posterior gastroenterostomy for duodenal ulcer during 1929 at Rochester, Minn., as nine deaths out of 492 cases, 1.82 per cent., and in gastric ulcer as one death out of twenty-one cases, 4.7 per cent. mortality. One must keep in mind, however, the marvelous perfection of technic and the wonderful personnel at the Mayo Clinic. Such happy conditions can hardly be duplicated everywhere and we must not be surprised to find that the statistics at other clinics are not quite so brilliant as those of the Mayo Clinic. Thus the late Doctor Peck reported in the Transaction of the American Surgical Association a mortality of 10 per cent.; Doctor Poole reported, in the same publication, a mortality of 7 per cent. Finney, reporting the results of himself and others in the past sixteen years (Archives of Surgery)

16 per cent., mortality following gastroenterostomy, and Munroe, of Boston, recently published in the Archives of Surgery operative mortality attendant upon gastroenterostomy, pyloroplasty, *etc.*, as 6.9 per cent. In various German publications a similar mortality rate attends operations of gastroenterostomy, pyloroplasty, and ulcer excision. A comparison of the mortality of these operators with that of primary subtotal gastrectomy shows that the latter is materially less.

In the past six years, we have had a number of patients with gastric ulcer situated at, or juxta to, the cardiac opening of the stomach. We call such situated ulcers "high gastric ulcers." As a rule, we operate upon these patients only when we are compelled to, because the attendant risk is exceedingly great. The compelling indications for operation are repeated severe hæmorrhages, perforation, stenosis of the cardiac opening, perigastric inflammation and suppuration. These ulcers are particularly difficult to deal with surgically because the adjoining portion of the œsophageal wall is infiltrated

FIG. 23.   FIG. 24.
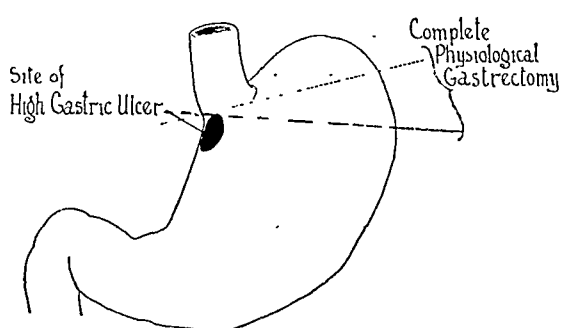
Complete gastrectomy may be: (1) *Anatomically complete,* when the line of section is above the cardiac ring. (2) *Physiologically complete,* when the line of section extends from the cardiaa on the right to just below the top of the fundus on the left. The advantage of the latter is an easier and safer gastro-jejunal anastomosis.
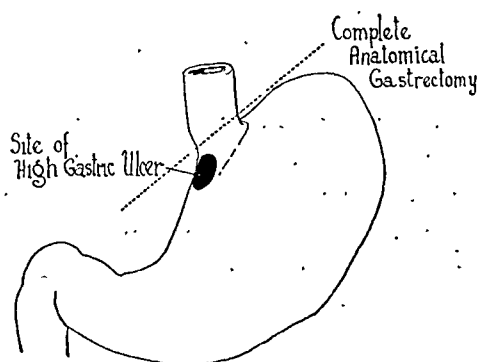
by inflammatory tissue, thus rendering suture difficult, and because the incidence of post-operative pneumonia is exceptionally high. We divide the operations which we have employed for the removal of such high-seated ulcers into two types—*total, or anatomically complete gastrectomy,* where the line of division goes through the lower end of the œsophagus at or above cardiac ring, and *physiological complete gastrectomy,* where the line of division goes through *one wall of the œsophagus and through the very topmost portion of the fundus,* leaving just sufficient of the fundus to hold the gastric half of a Murphy's button, by means of which the anastomosis can be readily made with the jejunum.

Number of operations for high gastric ulcer
(By high gastric ulcer is meant one that is *at* or *juxta to* the cardia)
Complete gastrectomy

	No.	Deaths
Anatomically complete	1	1
Physiologically complete	5	3

Secondary operations for recurrent ulcers of the stomach and duodenum and for gastrojejunal and jejunal ulcers including gastrojejunal colic fistulæ. We have already defined secondary operations as those which are performed after one or more primary major gastric operations have been done. We will deal with these secondary operations in detail in a subsequent publication. For the present, suffice it to say that in this series the number of operations performed before the partial gastrectomy was done varied from one to fourteen. In several cases, two preceding gastroenterostomies had been established side by side. In a large number of the cases a primary gastroenterostomy was followed by gastrojejunal ulcer; the latter had been excised, the stoma disconnected, and a recurrent gastrojejunal ulcer had formed. In one, a preceding Finsterer operation had been done (resection for exclusion of the pylorus). Some of the most difficult cases to deal with were the recurrent duodenal ulcers after primary excision of the ulcer and pyloroplasty. In two cases an abscess cavity as large as a hen's egg formed around the ulcerated duodenum, the entire anterior wall of the duodenum having perforated and ulcerated away. The abscess wall in these two cases was one-half inch thick; it could not be removed, and its lining had to be excochleated. A review of the histories of these patients will reveal, not only the frequent failure of conservative operations to bring about a radical cure, but will also show the frequent frightful complications that are attendant upon these conservative operations.

Of these secondary operations, we have had, in the period under discussion, a total number of 105, with twenty-two deaths, a mortality of 20.9 per cent. Strictly speaking, this mortality is not to be put down to partial gastrectomy, inasmuch as all these deaths occurred in patients who had a primary gastroenterostomy, ulcer excision, or pyloroplasty. These had failed to bring about a cure and, inasmuch as the lasting cure is the aim of the surgeon and the desire of the patient, and inasmuch as a secondary partial gastrectomy had to be resorted to before this lasting cure could be brought about, it would seem to the writer that the mortality attendant upon secondary operations is to be added to the mortality of primary gastroenterostomy, pyloroplasty, and ulcer excision, and that the sum total of this mortality should be compared with that resulting from primary partial gastrectomy.

The time that has elapsed for the observation of patients in whom a primary subtotal gastrectomy was performed is still too short to draw any positive conclusions as to lasting cure. We have, in preceding publications, insisted upon a ten-year period of observation. The cases reported in this paper have been under close observation from one to six years. We have been able to keep in touch with about 60 per cent. of our ward patients and about 80 per cent. of our private patients. The cases reported in this paper are about 50 per cent. ward and 50 per cent. private patients. Though we are not able to report, this evening, on the late results after as long a period as with the gastroenterostomies, nevertheless, we can compare the results following gastroenterostomy, *etc.*, after six years with those that have

followed partial gastrectomy after six years. Doctor Lewisohn investigated the late results following gastroenterostomy for ulcer and found them to be as follows: In 68 cases of gastroenterostomy for ulcer of the duodenum, re-examined from 4 to 9 years, 47 per cent. were completely cured; 19 per cent. had a fair result and 34 per cent. had gastro-jejunal ulcers. The diagnosis of gastro-jejunal ulcer was confirmed by secondary operation in 18 per cent. and in the remaining 16 per cent. was based on clinical symptoms and X-ray findings. In comparison with gastroenterostomy, we have had four cases of probable recurrence of ulcer in the ward patients and two cases of definite recurrence in private patients. Of the latter, one died. His history is of interest. His ulcer symptoms commenced when he was fifteen years of age. At eighteen years I performed a gastroenterostomy. After gastroenterostomy he remained fairly comfortable for about ten years and then suddenly, one night while he was free of symptoms, the duodenal ulcer perforated. This was closed by suture. Examination showed that the gastroenterostomy was sufficient and normal. Six months after the perforation, symptoms of gastrojejunal ulcer developed. This latter gave rise to repeated hæmorrhages, severe suffering and emaciation, and necessitated a partial gastrectomy about two years later. At this operation a large penetrating marginal ulcer was found. The original duodenal ulcer was healed. The gastric secretion was always hyperacid. After the last operation, he was well for about a year. Symptoms of hæmorrhage, pain, and disability then set in. After utter failure of all medical means of treatment, he had to be reoperated upon. A large perforated ulcer of the jejunum was found penetrating into the root of the mesentery and retroperitoneal tissues. Excision of this ulcer was extremely difficult. He was progressing well until a suppurative pylephlebitis developed and he died from the results of the suppurative pylephlibitis about two weeks after the last operation. At his death he was about thirty-five years old. This history is of importance as showing that the man suffered with ulcer in one form or another for a period of over twenty years. Gastroenterostomy had brought relief for a number of years but did not prevent a perforation of the original ulcer years afterward. The case is of further interest as showing the long period that elapsed (over ten years) before the formation of a gastrojejunal ulcer. On numerous occasions, we have noticed, that *when the duodenal ulcer heals after gastroenterostomy, either a new gastric ulcer or a marginal or jejunal ulcer forms, and when this last-named ulcer has been excised and the stoma disconnected, the original duodenal ulcer reopens.* So, in this patient, when the duodenal ulcer had perforated and healed, a gastrojejunal ulcer developed. The persistence of his high acidity after partial gastrectomy made him susceptible to the formation of jejunal ulcer for the operative relief of which he succumbed.

The other private patient had a simpler history. A gastroenterostomy had been done several years before for a duodenal ulcer. At the site of the new stoma a gastrojejunal ulcer developed and for the cure of this ulcer a partial gastrectomy had been done. The gastric contents remained persistently

hyperacid, and several years after the partial gastrectomy he developed a jejunal ulcer. A further resection of the stomach and resection of the jejunum and left vagus section were made. Patient made a good operative recovery. At the present time he is free of all symptoms. His gastric contents, six months after last operation, are subacid.

We are strongly suspicious of recurrent ulcer in four ward patients but are by no means sure of it. Three of these patients are able to attend to their daily work, but have occasional periods of pain. Their gastric contents all show free hydrochloric acid. X-ray examination sometimes reveals a tender stoma, and in two there seems to be a penetrating ulcer at the new anastomosis. At other times the X-ray examinations are entirely negative. Their sufferings are so mild in character that they are unwilling to be operated upon. All three maintain or have gained in weight. We class these cases amongst the recurrent ones but, as stated above, we are not at all convinced that they belong positively in this category. The fourth ward patient is put down as a recurrent case because he complains of ulcer symptoms. Objectively, neither by physical examination nor by X-ray, have we found any evidence pointing to a recurrence. His gastric contents are subacid.

Thus, out of a total of 516 cases of primary and secondary partial gastrectomies, we have but two cases of undoubted recurrence, three cases of probable recurrence, and one case of possible recurrence. All six patients have had free hydrochloric acid in their gastric contents. If all six cases are put down as positive recurrence, the percentage would be 1.1. In a similar period, I have shown from the statistics of Doctor Lewisohn, above quoted, in the same clinic, that, with the same character of patients, with the same kind of ulcers, the percentage of recurrence was 34 per cent.

There need be very little more said when these results are compared. The patients who have had a partial gastrectomy are vigorous, strong, eat all kinds of food, are able to do their work; their intestines function, for the most part, normally, and there is a percentage of recurrent ulcer of 1.1 per cent. Those who have had gastroenterostomy, *etc.*, performed never measure up to those who have had partial gastrectomy done. While some of them eat everything, the majority must be careful of their diet and the percentage of recurrence is over 30 per cent. It is such a comparison as this that confirms our belief in the value of partial gastrectomy as a cure for gastric and duodenal ulcer.

When we commenced our work on partial gastrectomy for the cure of ulcer we had reason to believe that by the removal of the antrum the gastric contents would be rendered anacid. It was thought that the secretion elaborated by the antrum stimulated the acid gastric glands to action and that the removal of this secretion would remove the motor that caused the acid glands to secrete free hydrochloric acid. We were particularly happy in our early cases to find that after partial gastrectomy gastric secretions were anacid. At that time we were using the Ewald test meal and the meal was

extracted about an hour after its ingestion. When we replaced the Ewald test meal by the fractional test meal (Rehfus), we found that gastric anacidity did not always follow upon partial gastrectomy. Dr. Eugene Klein, of our clinic, took up a careful investigation of this subject and his results are shown in the following table:

Maximum Free Acid After Partial Gastrectomy in Fractional Test Meals

Duodenal:	Anacid	0–20	20–50	50 and above	Number of cases
Before operation		4 per cent.	36 per cent.	60 per cent.	50
Recent	9 per cent.	9 per cent.	46 per cent.	36 per cent.	11
Old	25 per cent.	41 per cent.	17 per cent.	17 per cent.	12
Gastric:					
Before operation		28 per cent.	60 per cent.	12 per cent.	25
Recent	45 per cent.	33 per cent.	11 per cent.	11 per cent.	9
Old	100 per cent.	....	....	....	3
Gastrojejunal:					
Before operation		11 per cent.	67 per cent.	22 per cent.	9
Recent	25 per cent.	25 per cent.	50 per cent.	....	4
Old	50 per cent.	....	50 per cent.	....	2

("Recent," refers to cases examined immediately after operation; "old," to cases examined six months after operation; "before operation," in gastrojejunal group, refers to cases examined before partial gastrectomy.)

The results of this investigation showed us that partial gastrectomy did not always bring about an anacidity and we had long ago learned that as long as the gastric contents remained acid the possibility of recurrence existed. It will be noted from the above table that all of the gastric ulcers were followed by an anacidity of gastric contents and in no case of gastric ulcer treated by partial gastrectomy have there been evidences of recurrence. The six cases with possible recurrence referred to above have all been duodenal ulcers. It is reasonable to conclude that the higher the percentage of free acid in the gastric contents, the greater the possibility of recurrence. Patients with duodenal ulcer who have a low or moderate acidity prior to partial gastrectomy all become anacid or considerably subacid after partial gastrectomy. Thus, it is only those who have hyper amounts of acid before the operation of partial gastrectomy, that maintain this acidity after the antrum and part of the body of the stomach have been removed. It is to this class of cases that we devoted our attention, to see whether we could not render them completely anacid or markedly subacid. Doctor Winklestein approached this question in a medical way and Dr. Eugene Klein dealt with it in an experimental operative manner. Their results have been published elsewhere. We found, experimentally, that the division of the left pneumogastric nerve as it passed through the cardiac opening of the stomach rendered patients completely anacid who were highly acid prior to partial gastrectomy, and whom we had every reason to suppose would remain acid after the partial gastrectomy. Some of these patients, and there were sixteen altogether,

became anacid two weeks after the operation and the rest of them became totally anacid several months after left vagus section. None of the patients in whom a left vagus section was made died or showed any untoward results. The division of the left vagus nerve at the cardiac opening of the diaphragm can be rapidly done without any added risk and with no untoward symptoms or disturbances. We do it now regularly in all patients who have high acidity prior to operation. This question will be dealt with in subsequent publications.

Quite a number of patients who suffer with gastric and duodenal ulcer present the symptoms of vagotonia prior to any operative interference. Frequently these vagotonic symptoms are more distressing than those resulting from the ulcer. These vagotonic symptoms are not at all dependent upon the ulcers but accompany them. It is readily seen, therefore, that they are not very likely to be influenced by any of the procedures that are employed for the cure of ulcer. In our follow-up clinic we see quite a number of patients who complain of dizziness, headache, sweating of the palms, cardiac palpitation, even though they are entirely free of all gastroenteric disturbances. Tonics, roborant treatment of all kinds, and sunlight treatments are all of help in ameliorating this type of complaint. We have not seen that the patients are incapacitated from their usual occupations by the existence of these vagotonic disturbances.

In this series of 516 patients there were quite a large number who came to us in the active period of bleeding. In a considerable percentage of these cases the hæmoglobin had fallen to 20 to 30 per cent. It is not our practice to operate in the active stage of bleeding unless the bleeding is persistent and continuous. It is our practice to wait until hæmorrhage stops and then, after one or more transfusions, to proceed to operate. In three of the patients of this series we were compelled to operate because the hæmorrhages had been persistent for three weeks or more, even though the individuals were in a practically moribund condition. All three of these patients died. These three patients should be taken out of the mortality statistics because we knew in advance that death would ensue and it was only in the hope of saving a lost life that operation was undertaken. In all three of these cases operation should have been resorted to before the patient's condition became so desperate. When the patient is very anæmic prior to operation, either because of loss of blood or because of the pains and suffering and toxæmia resulting from the ulcer or from both combined, it takes a long time (six months to a year) before the anæmic condition is improved. Now and then a transfusion will help, but, as a rule, the slower building-up process by fresh air, nourishing food, heliotherapy, and tonic is more effective. For the first six months after the operation the patient seems to remain stationary. His blood-picture changes very little but once he commences to improve, his progress is rapid and steady. *We have not seen any case of pernicious anæmia following partial gastrectomy.*

Much has been said concerning the comparative results of medical and

surgical treatment for the cure of gastric and duodenal ulcer. The surgeon
has been content, even to the present time, to take his cases for operation
from those who have resisted repeated efforts on the part of the internists
to bring about a cure and from those who have suffered from cicatricial
stenoses and malformations of the stomach as the result of the healing process.
The time has come when the experience of the surgeon in the radical cure
of ulcer should be set side by side with that of the medical man. We believe,
as do most surgeons, that the patient suffering from ulcer should have at
least one thorough-going medical treatment. If this prove inefficacious, then
the patient should be told that continuation of the medical treatment will serve
only to relieve the symptoms, but will not be likely to effect a cure. The
result of partial gastrectomy in the cure of ulcer has been carefully given
in the preceding pages. It is well to glance at the late results of medical
treatment. A few years ago, Dr. B. Crohn made a study of his cases in the
out-patient department of the Mount Sinai Hospital, the results of which are
hereby given.

Remote Results of Medical Treatment
in Percentages

Year	Cases .	Period of Follow up	Cured	Impr.	Unimpr.	Oper.	Perfora- tion	Death
1922........	22	4 year	27.3	22.7	9.1	31.8	9.1	4.5
1923........	17	3 year	41.2	23.5	5.9	23.5	0.	5.9
1924........	30	2 year	56.6	10.	6.6	23.3	0.	3.3
1925........	32	1 year	67.5	22.	9.4	1.1	0	0

A larger number of cases was analyzed by Nielsen, and the results pub-
lished in the Acta Scandinavia. These results are

Ultimate Results of Medical Treatment of Gastric and Duodenal Ulcer
$2\frac{1}{2}$ *to 20 years after discharge from Hospital. (Nielsen)*

Duration of Symptoms	Permanently Cured	Permanently Cured after Relapse	Total Permanently Cured	Improved	Bad Results
Symptoms less than $\frac{1}{2}$ year before treatment—30 cases..	60 %	0	60 %	16.7%	23.3%
Symptoms $\frac{1}{2}$ to 1 year before treatment—24 cases.......	33.3%	20.8%	54.1%	16.7%	29.2%
Symptoms 1 to 3 years before treatment—19 cases.......	26.3%	10.6%	36.9%	21 %	42.1%
Symptoms 3 to 5 years before treatment—15 cases.......	20 %	0	20 %	26.7%	53.3%
Symptoms 5 to 10 years before treatment—37 cases.......	2.7%	8.1%	10.8%	10.8%	78.4%
Symptoms over 10 years be- fore treatment—35 cases....	5.3%	0	5.3%	17.6%	77.1%

The consideration of these medical results by two independent investi-
gators shows that medical treatment fails to bring about a lasting cure in a
large percentage of the patients. If the results already obtained by partial

gastrectomy are further substantiated by continued observation, is it not fair to conclude that where patients have not been cured of their ulcer by one or two good medical treatments, they should be advised to undergo operation?

It is a common fallacy to believe that medical treatment of ulcer is unattended by any risk. This is not in accordance with facts. In our hospital, during a period of about ten years, about 1 per cent. of ulcer cases under medical treatment died from hæmorrhage; at least 1 per cent. died from perforation; a small percentage of gastric ulcers developed carcinoma. Quite a large percentage of patients, while under medical treatment, die from inanition, toxæmia, and renal, cardiac, and pulmonary complications. If all of these causes of death are counted up the mortality attendant upon palliative medical treatment of ulcers is considerably higher than that attendant upon the radical surgical treatment.

In concluding this paper the writer wishes to call attention to several important facts concerning ulcer. Firstly, ulcer of the stomach and duodenum is a local disease dependent upon a specific gastritis, free hydrochloric acid in the stomach contents, and a secondary infection. Secondly, a radical cure must eliminate all of these factors. Thirdly, experience has shown that partial gastrectomy, because it eliminates all of these factors, is most likely to effect a radical cure. The number of recurrences after partial gastrectomy is exceedingly small—about 1 per cent. Finally, investigation has shown that the medical treatment of ulcer is attended by just as grave risks as is surgical treatment, and, unless instituted very early, is not likely to bring about radical cure; and that when a patient has had one or two good medical treatments and has not been cured, operative procedure should be undertaken.

DISCUSSION

Dr. Harold E. Santee* reported the results of gastric resections performed in the Cornell Division at Bellevue Hospital. Of 105 cases, twenty-six are immediately eliminated as carcinoma, although not all appeared certain at the time of operation. Of the remaining seventy-nine, ten were secondary resections in the sense that previous gastroenterostomy or resection had been performed. All other cases are considered primary, whether previous operation on stomach or abdomen had been performed. It is this group of sixty-nine that he had considered, a small group, but offered at its face value.

The cases immediately divide themselves into twenty-six duodenal ulcers and forty-three gastric ulcers—a division which Doctor Santee believed should be made for the reason that a resection for an average duodenal ulcer is technically a much smaller operation than a resection for a gastric ulcer with its possible complicating features. Moreover, the age incidence in the duodenal group is thirty-three and one-quarter years as against forty-

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*Meeting of the Surgical Section of the New York Academy of Medicine, March 7, 1930.

four and one-half years in the gastric group. Of the duodenal group, three died, or 11.5 per cent.—one from shock (aged twenty-seven), one from pneumonia and myocarditis (aged sixty-one), one from pneumonia and lung abscess (aged twenty-nine). Of the gastric group, seven died, or 16.3 per cent. Their average age, including one of thirty, was fifty-one years. The causes of death apparently were shock (two, aged fifty-six and forty-three), pneumonia (two, aged forty-four, with lung abscess, and aged forty-three), myocarditis (one, aged sixty-four), progressive anæmia and asthenia (one, aged fifty-five), obstructed anastomosis with secondary operation (one, aged thirty). In two of these cases, pre-operative bleeding from the ulcer played a major part in the fatal ending. The procedure was perhaps ill-chosen and unwisely executed. One would hope to save some of them now by better judgment and more available transfusion funds. This gives a mortality percentage of 14.5 per cent. for the entire group. So much, then, for statistics. It becomes evident, then, that this operation packs a potential wallop which often becomes real in the face of complicating features or increasing age. Judgment, experience and the wiser handling of patients pre- and post-operatively should materially reduce these figures. They represent, however, the work of several men and perhaps may be taken as an average in the small group of cases.

Is this operation, then, a procedure of choice in duodenal ulcer? About three years ago, Doctor Santee was practically converted to such a view by Doctors Berg and Lewisohn, abetted as they were by the Finsterers and Haberers of the profession. A number of resections for duodenal ulcer resulted. Now he feels differently. Until the cause of gastric and duodenal ulcer is definitely determined, treatment must be empirical. The most recent contribution to the specific etiology is about to be published by Saunders of the Bellevue staff, working in the Cornell Department of Experimental Surgery. With special media, he has consistently recovered from ulcers resected by Doctors Berg and Santee a non-hemolytic alpha streptococcus (not viridans, not hemolytic, not Rosenows), the specificity of which seems to be proved by its constant agglutination in small titre by the patient's blood serum. With this same streptococcus, typical chronic indolent ulcers have been produced in the skin of dogs. It is a significant finding and possibly points the way toward accounting for the chronicity of gastric and duodenal ulcer under medical treatment and the latency and reactivation of such ulcers under surgical treatment when stomas close or gastroenterostomies are undone. Whatever the etiology, however, gastroenterostomy presents for the properly chosen duodenal ulcer a precedure perhaps equally empiric to resection but not equal to it in mortality and attended, Doctor Santee believed, by very satisfactory results. In a recent review of 202 of their cases, such mortality was 2.9 per cent. Satisfactory results were about 85 per cent. Felter, of the Bellevue staff, in a Cornell Clinic follow-up of approximately 100 such cases done by forty-odd surgeons in twenty-five hospitals in Greater New York, finds an excellent result in 75 per cent.

and good in 17 per cent., a total of 92 per cent. of satisfactory results in that economic status and physical comfort have been reëstablished and qualitative and quantitave indigestion reduced to a minimum. All these cases were individually and personally seen, talked with, examined and fluoroscoped. In not over 3 per cent. is there a suspicion of marginal or jejunal ulcer. Personally, he believed the occurrence of the latter lesions to be not over 5 per cent. Did he believe it to be as large as quoted in some clinics, he would be conscientiously forced to give up gastroenterostomy because marginal and jejunal ulcers are miserable conditions and their cure attended by grave risk.

Gastric ulcer as considered against duodenal ulcer presents a different problem. Its complicating features as to position, size and penetration, its potentialities or realities as to malignancy, combined with the fact that local excisions and gastroenterostomies are in no way as satisfactory as in duodenal ulcer, lead him to accept resection as the operation of choice. The wise man, however, will recognize his own limitations in the face of technical difficulties, such as a high ulcer on the lesser curvature, and may very well in the best interest of his patient sacrifice the ideal procedure to the immediate welfare of such patient.

As to a statistical study of late results he will offer little at this time. One subtotal resection in which the pyloric ring was left in developed a definite jejunal ulcer. Through Doctor Berg's courtesy, he later saw him make this resection more subtotal. Two cases, one a chauffeur and one a colored cook, have been much distressed by an absolute lack of hunger for almost a year. It particularly peeved the colored cook. Others have complained of fullness after eating too rapidly or too much. Considering the mechanical conditions present, however, after resection, he has been surprised at the small number of such complaints. If he might be permitted an expression of opinion on what he acknowledges to be insufficiently studied data, he would say that the resected cases present the happier and better cases at the return clinic if they arrive there and that this operation is the operation of choice in gastric but not duodenal ulcer.

Dr. John Douglas remarked that Doctor Berg had presented a very convincing argument for the radical operation for the cure of gastric and duodenal ulcers. His argument is based primarily on three ideas: first, that operations other than a subtotal gastrectomy are ineffectual in the cure of gastric and duodenal ulcers; second, that the danger of a radical operation is not sufficiently great to be a contra-indication to its use; third, that subtotal gastrectomy is a cure.

Considering first the mortality and danger of the operation, Doctor Berg has presented a very low mortality rate for such an extensive operation. Certainly the mortality rate for gastric resection by most other surgeons is larger than Doctor Berg's statistics show. Perhaps this may be due to Doctor Berg's dexterity. But a gastric resection, where the stomach

is free and uninvolved and the lesion present a small duodenal ulcer, would of course give a smaller mortality than where other surgeons are performing a group of these operations for gastric ulcer, which may be high on the lesser curvature, have formed adhesions to the pancreas, and caused deformity of the stomach, all of which greatly increases the difficulty.

As to the poor results of the less radical operations which are reported from many foreign clinics as well as from Mt. Sinai, it has been the belief in St. Luke's Hospital that the less radical operations have not shown such poor results. The speaker had occasion to check up on the follow-up of a group of cases that were operated on in St. Luke's Hospital previous to the year 1925, so that in none of these cases is the follow-up less than five years. These operations were performed by the different surgeons on the staff and the patients have recently been checked up on in order to determine their present condition. In this group, while the statistics and classification are as yet incomplete, there were 204 duodenal ulcers—excluding perforated cases—a simple posterior gastroenterostomy having been done on 135. Of these 135, four died, making the mortality rate 2.9 per cent. They had been able so far to get a follow-up for a period of five years or longer on only sixty-five of these cases. Of these sixty-five, the result was satisfactory in fifty-eight, giving a good result of almost 90 per cent. There were nine deaths in the total of 204 cases (without perforation), making the mortality rate 4.4 per cent. for all operative procedures. Including the cases of perforation, the mortality rate was 8.9 per cent. The less satisfactory results in the duodenal cases were in those where a pyloroplasty of some type had been performed or a simple closure of a perforation done. Frequently, this pyloroplasty was done as part of an operation for a perforated ulcer. In the 150 gastric ulcer cases they were able to get a five-year follow-up on only sixty-three cases. In thirteen of these, the result was unsatisfactory, which would leave only an 80 per cent. good result and the mortality higher. The mortality showed thirteen deaths in 146 cases where death did not follow an operation for perforation, or 9 per cent. This included thirty-six resections of some part of the stomach.

Now as to statistics. In going through these cases it has been exceedingly difficult to determine how to qualify cases. Many cases are relieved of any and all gastric symptoms. Some have symptoms unless a careful diet is followed. Others suffer distress only after alcoholic or dietary indiscretions that even a normal stomach could not stand. Furthermore, in the follow-up clinic, it has been observed that many patients, several years after their operations, during which time they have been relieved of symptoms, come to the return clinic with very bad teeth or other focal infection, and it is my belief that so long as a condition of that kind exists even a gastrectomy may result in a return of symptoms.

One of Doctor Berg's contentions, as well as of others advocating a radical operation for an ulcer of the stomach or duodenum, has been the frequency of gastrojejunal or jejunal ulcers. Doctor Douglas had been

able to find in the records at St. Luke's Hospital fifteen of these cases. In many of these the primary operation was done elsewhere. In some the operation was done at St. Luke's Hospital. In five of these cases no operation was done and the diagnosis has been somewhat questionable. One of these cases, where there was a gastrojejuno-colic fistula, had had a subtotal gastrectomy done in one of the large clinics by one of the best surgeons in the country. The operation had been most radical. The patient died in St. Luke's Hospital without an operation for his fistula and the condition was confirmed at autopsy. A similar case of recurrence occurred after resection done at St. Luke's Hospital. Many other cases have been reported of marginal ulcer after gastric resection, although he believed it is Doctor Berg's contention that these were not subtotal gastrectomies but pylorectomies. It would appear, however, that in a few cases recurrence of ulceration may occur no matter how radical an operation is done.

He believed it to be an unfortunate fact that this contention among surgeons, of the inadequacy of less radical operations and the danger of more radical operations, has caused many medical men to distrust all surgery for gastric and duodenal ulcers. For while a very fair percentage of gastric and duodenal ulcers can be cured by non-surgical measures, so that careful medical treatment should always be tried first, there still are many cases which can be relieved and cured only by surgery. And, while one admits the strength of Doctor Berg's argument, one still feels that he would prefer to have the less radical operation done in his own case for a duodenal ulcer, rather than a subtotal gastrectomy. In cases of gastric ulcer, because of the real danger of carcinoma being present and because of more unfavorable results by less radical operations than in duodenal ulcer, he thought a subtotal gastrectomy had its real and definite place.

DR. SEWARD ERDMAN felt that his own personal experience with partial gastrectomy was so limited, and the total of such cases on the Second Surgical Division of the New York Hospital was so small in comparison with the 515 cases reported by Doctor Berg, that he would not attempt an analysis of his cases, other than to say that the mortality at the New York Hospital was very much higher than that reported by Doctor Berg. Therefore his discussion would consist chiefly in challenging the theory that partial gastrectomy should be the standardized operation for duodenal ulcer; also in attempting to refute certain other statements made by Doctor Berg on this and on previous occasions.

1. Results of gastroenterostomy for duodenal ulcer.—From Doctor Berg's service at the Mt. Sinai Hospital, Lewisohn, in 1925, reported 34 per cent. of gastrojejunal ulcers, and only 50 per cent. cures, following gastroenterostomy for duodenal ulcer and pyloric ulcer, during the years from 1915 to 1920.

This unique finding is given as a reason for abandoning gastroenterostomy and adopting subtotal gastrectomy.

How widely different has been the experience of a number of other surgeons of this country and of England, is shown by the end-results in 234 traced cases of duodenal ulcer treated by pyloroplasty or gastroenterostomy, reported by Finney (ANNALS OF SURGERY, November, 1929), in which series 90 per cent. of those who survived operation were well or improved for periods of from two to twenty years. He also states that 5 per cent. is a conservative estimate of the occurrence of marginal and jejunal ulcers after gastroenterostomy.

The late Doctor Peck, of New York, reported over 80 per cent. good results from gastroenterostomy; Walton and Moynihan each report over 90 per cent. good end-results, as do the Mayos.

By all these surgeons, the occurrence of secondary ulcers and marginal ulcers runs between 2 per cent. and 5 per cent., following gastroenterostomy.

The practical agreement of these reliable surgeons that gastroenterostomy for duodenal ulcer gives good results in nearly or quite 90 per cent., serves to greatly weaken the argument by Doctor Berg in favor of gastrectomy, based on his own singularly unfortunate results with gastroenterostomy.

2. Operative mortality.—Doctor Berg has chosen to lay much stress on his low operative mortality following partial gastrectomy and for his purposes he classifies the operative deaths as follows: in a total of 515 gastrectomies, there were thirty-two deaths following so-called primary operations, twenty-two deaths following secondary operations, and four deaths in a small group of nearly total gastrectomy.

These fifty-eight deaths in a series of 515 cases, give 11 per cent. operative mortality, or over 10 per cent., even if the four deaths in the more radical resections are omitted.

Doctor Berg has shown a table of operative mortality in series of gastroenterostomy cases by other surgeons, to contrast with his 6.7 per cent. mortality in the selected group of primary partial gastrectomies.

He cites the following mortalities following gastroenterostomy: Finney, 16 per cent.; Peck, 10 per cent.; Mason, 6.9 per cent.; Pool, 7 per cent., but these men all included primary and secondary operations without distinction, and, at least in Finney's and Pool's series, represented operations by a large number of different surgeons. Finney included all deaths occurring within six months after operation.

A fairer estimate of the relative mortality of gastroenterostomy and of gastrectomy is afforded by the reports from the same individual surgeon; thus, Moynihan had 1 per cent. mortality in gastroenterostomy—indeed, 500 consecutive cases without a death—but finds the mortality after gastrectomy runs from 5 to 10 per cent.

Others, such as Balfour, Mayo, and Walton, who had under 2 per cent. mortality from gastroenterostomy, acknowledge 10 per cent. or five times as great mortality after gastrectomy.

In general, among surgeons who speak our language both literally and

surgically, one finds that gastrectomy has a very much larger mortality, where all deaths are included.

3. Does partial gastrectomy produce "total and permanent anacidity"? Such was the claim made by Doctor Berg in a talk given by him several years ago in the Academy of Medicine on Forty-third Street.

We believe that neither Doctor Berg nor Doctor Lewisohn would adhere to such a claim at the present. Indeed, from Doctor Berg's service at the Mt. Sinai Hospital, Klein reported in the ANNALS OF SURGERY, July, 1929, that of the cases examined after gastrectomy for duodenal ulcer, 17 per cent. showed persistent "hyperacidity," and only one-quarter are anacid.

The ordinary Ewald test meal is no longer considered reliable. E. Perman (Zentralbl. f. Chir., 1927), made interesting observations on cases after gastrectomy for ulcer, but where a temporary gastrostomy had been added after the Witzel method. In five such cases after a Billroth No. 1 operation, all five showed free hydrochloric acid, one in slight amount and four in large amount. In fourteen cases following Billroth No. 2, three showed anacidity, four showed small amount of free acid and seven showed approximately normal acidity. At the same time he examined fourteen cases of Billroth No. 2 without Witzel fistulæ, using a test breakfast, and found nine cases anacid, and five with small amounts of acid. He concludes that after Billroth No. 2 operations the test breakfast is misleading probably because contents leave the stomach almost immediately, whereas through the Witzel fistula there is little admixture with the duodenal content.

Therefore even if only 17 per cent. of cases remain hyperacid after gastrectomy, as admitted by Klein, one cannot claim immunity from secondary ulcers if acidity is the cause.

4. Does gastrectomy grant immunity from subsequent ulcer formation? Several years ago, in the old Academy of Medicine, Doctor Berg stated that he was obtaining 100 per cent. cures, based on his experience with his earlier gastrectomies.

Balfour, in 1928, reported that he had already operated upon twenty-eight cases of recurrent and marginal ulcers following gastrectomy for ulcer.

Moynihan (Brit. Med. J., 1928), had collected from literature 100 cases of jejunal ulcer after gastrectomy.

H. K. Louria, of Brooklyn (S. G. O., October, 1928), reports on 179 gastrectomies for ulcer, operated upon in Haberer's Clinic, and followed for from one to three years. About one-half of these were examined at the clinic and one-half reported by letter. Of the 107 cases of gastrectomy for duodenal ulcer, only 83 per cent. were classed as good results.

Therefore, the facts are that marginal and jejunal ulcers may and do occur even after the partial gastrectomy.

5. Duodenal ulcers and gastric ulcers are put in the same classification, by Doctor Berg, who adds that "the life history is the same."

Whatever truth there may be in this contention, so far as the etiology and pathogenesis is concerned, the similarity ceases when one considers the

much-discussed question of the possible development of cancer on an ulcer base, for such a cancerous change is never encountered in duodenal ulcers, although it does occur in a small percentage of ulcers of the stomach.

Regarding the frequency of such cancer in cases of gastric ulcer, there is wide divergence in medical opinion, although this possibility advanced by Rodman many years ago is often given as the reason for choosing gastrectomy for ulcer of the stomach.

If the development of cancer on an ulcer base is to be regarded as a pathological sequence and not a mere coincidence, then the site of election for cancer should correspond with the site of election for ulcer of the stomach, but apparently this is not so.

Moynihan in a series of 2000 gastric ulcers studied, found less than 3 per cent. at the pylorus or within one and a half inches thereof, the vast majority being on the lesser curvature.

On the other hand, Welch, quoted by Ewing, in a study of 1300 cases of carcinoma of the stomach, found 60 per cent. to be located in the pars pylorica, 20 per cent. on the lesser curvature and 20 per cent. on the greater curvature.

From these two studies it therefore appears that 60 per cent. of cancers occur in that portion of the stomach where only 3 per cent. of ulcers are found.

Finally we would quote Moynihan (Brit. Med. J., 1928): "Gastrectomy for duodenal ulcer is neither safe nor simple and does not give better end-results than gastroenterostomy. The worst of gastroenterostomy is known and the best is unsurpassable. We have yet to learn the worst of gastrectomy and what we know is unfavorable enough."

We admit that Doctor Berg has shown "how" gastrectomy may be performed for duodenal ulcer, but we remain unconvinced as to "why" it should be done.

DEFORMITIES AND OBSTRUCTIONS OF THE STOMACH AND DUODENUM

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The main causes of deformities and obstructions of the stomach and duodenum are: (*a*) ulcer; (*b*) cancer; (*c*) gall-bladder; (*d*) periduodenal membranes and bands; (*e*) diverticula of the duodenum and (*f*) compression of the duodenum by the superior mesenteric or median colic arteries.

There is a well-defined pathological anatomy and disturbed function produced by these conditions, exhibiting them clinically and by X-ray studies in at least 84 per cent. of cases of ulcer and cancer, and in 87 per cent. of all cases combined and finally marked lasting benefit to the patient from proper choice of surgical procedures in about 90 per cent. of cases. There remains just as definitely about 13 per cent. of confused diagnosis and 10 per cent. of patients who are not altogether comfortable due either to the failure of the operation or to improper choice of the appropriate surgical procedure. Although a confused diagnosis in 13 per cent. of cases still exists in spite of elaborate clinical, X-ray and laboratory studies, and a failure to render the patient symptom-free in about 10 per cent. cases by the use of the various operative procedures, it is at the same time made evident that these percentages may be reduced by persistent clinical and X-ray studies, with elimination of other simulating conditions, and a developing surgical judgment of the proper choice of the basic operations now described. In other words, the armamentarium for diagnosis and treatment is now adequate if properly employed and interpreted. In reality even a "chronic ulcer" of the stomach and duodenum is a visible and palpable lesion present for months or years, though varying from time to time in its destruction of tissue and stubborn repair; there is a crater of varying size; the ulcer involves at least the muscle coat and sometimes all coats; the adhesions of the ulcer base to the neighboring structures prevent a gradual perforation and considerable deformity and constriction at the site involved.

The widely discrepant statements made by those medical men, physicians, surgeons and röntgenologists who have taken part in the many symposia and discussions of the subjects of gastric and duodenal ulcer, especially the contrary views of medical and surgical treatment, and more important the problem of carcinomatous degeneration at the edge of simple chronic ulcer, are most discordant and confusing to the average physician and surgeon, since the care of the patients and the responsibility of their future life and comfort are not confined to the "centers," from where most data and statistics on the subjects are assembled and compiled for discussion.

The writer accepts and grants that acute gastric and duodenal ulcers are

the province of the physician and not the surgeon, except when accompanied by recurrent hæmorrhage and perforation, and believes that hæmorrhage and perforation rarely take place in acute ulcers but usually in the exacerbation of a persistent callous ulcer, when the scar breaks down and a dormant ulcer is aroused to activity likely by revived infection. The writer does not know the percentage of carcinomatous change in simple chronic ulcer. He neither accepts the high percentages reported from the examinations of specimens from gastrectomy performed in the early stages of carcinoma as the only trustworthy evidence of the incidence of cancer in ulcer, nor the opinions of surgeons and röntgenologists that the incidence in simple ulcer is rare and that most ulcers accompanied by malignant changes are in reality and from the beginning of development ulcerated carcinomata. The writer has also carefully noted the location of prepyloric ulcer (in the cap), post-pyloric ulcer (in the antrum) and corporic ulcer (in the corpus, along the area of lesser curvature supplied by the left gastric artery) and has remarked on the apparent fact that his cases of cancer mostly did not give a history of previous ulcer and that the protractive cancerous ulcer not infrequently occurred in the fundus and near the greater curvature, outside the ulcer area. On the other hand the writer is anxious as to the destiny of any patient suffering with gastric ulcer, whether the possibility of change from simple ulcer to malignant is great or whether an appreciable percentage of ulcerative lesions of the stomach are carcinomatous. The possibility of malignancy, hæmorrhage and perforation in chronic duodenal ulcer give him deep concern and direct his attention to the resection of the ulcer.

Cole's conclusions, from the viewpoint of a röntgenologist are interesting: "Ulcers that occur nearer the greater curvature than the lesser should be considered ulcerations in carcinomatous areas and not benign ulcers."

"Any ulcer that increases in size, after the initial avulsion of the crater, should be considered malignant, or at least not a simple or benign type of ulcer. This increase in size must be determined by comparing röntgenograms made at the end of one week in bed, two weeks in bed and if necessary at the end of a third week in bed, care being taken that the patient is in the same posture during each examination." In other words, according to Cole, practically all benign ulcers in the corpus and in the antrum occur along the lesser curvature. He has never seen one that was not benign; thirty-six cases of ulcer of the corpus healed under medical treatment. In only one instance could the second ulcer have been a recurrence rather than a new ulcer. In every instance where a subsequent ulcer developed, the subsequent ulcer healed under medical treatment with as great or even greater rapidity than the original ulcer. Duodenal ulcers, or post-pyloric ulcers are practically never malignant, though so reported. One case in my series was so reported but time has proved the pathological diagnosis wrong. This report embraces 108 cases with four deaths; one of the deaths two years after operation from a cancer imposed upon a gastric ulcer which was bleeding at time of operation, but was not found. The bleeding stopped after a gastro-

enterostomy; the other death was in the case of an old woman who had been bedridden for years with rheumatism and a very bad heart which at times decompensated; she had a perforation of a chronic gastric ulcer on the posterior surface of the stomach near lesser curvature into the pancreas, and, after resection of the ulcer and closure of the pancreas, she died on the table before the wound was closed. Two cases of carcinoma with re-section of stomach, both within eighteen months from metastasis. (This series of 108 cases represents only a part of my work, since my records prior to 1922 were accidentally destroyed and certain protocols were lacking in sufficient data. While these cases are consecutive and not selected they are interrupted by other such cases where the records were incomplete.)

Using fifty of the above cases where the data was complete in every respect of clinical findings, X-ray studies and "follow-up," I have chosen the following data:

1. Ulcer or cancer confirmed clinically, confirmed by X-ray, found at operation, thirty-seven cases. Nineteen of these cases were carcinoma of the stomach, one case linitis plastica, nine were exploratory operations and nine were resections. Of the nine resections two are now dead from metastasis within eighteen months; of the nine exploratory operations all but one case is now dead within fourteen months. It will be noted that in accepting mortality in only those cases where operation was directed against the lesion itself is the death reported. It will also be noted that in all operations but one case failed to leave the hospital, and that case from heart failure on the table.

2. Ulcer confirmed clinically, not confirmed by X-ray study, found at operation, two cases. One of these was a perforation after negative X-ray study following three Sippy treatments of eight weeks each; the other was an ulcerative carcinoma with loss of forty-three pounds. Last case possibly carcinoma from the beginning, in early stage.

3. Ulcer confirmed clinically on account of voluminous hæmorrhage, not confirmed by X-ray, not found at operation, three cases. Two of these cases remained well following gastroenterostomy, the third case died two years later of carcinoma of stomach. Last case carcinoma on ulcer base.

4. Ulcer not confirmed clinically, found by X-ray, not found at operation, five cases. Two of these cases were an adhesive gall-bladder, one with stones bound down tight to the duodenum and a portion of the duodenum puckering between the adhesions, thus producing the artefact of an ulcer. One X-ray man was sure of an ulcer in one of these cases, with slow perforation to account for the pain, vomiting, distention, temperature and leucocytosis; another was doubly sure, even after the operation for liberation and removal of an acute cholecystitis. The third case was a large tuberculous ulcer near the hepatic flexure with surrounding adhesions and a very spastic duodenum, relieved by a colectomy. The fourth case was an obstruction due to adhesions and kink at the duodenojejunal junction and this is the case of duodenal obstruction on which a gastroenterostomy was wrongly done, followed by a

so-called "vicious circle" after operation. The fifth case was a very high lateral cecal and colic appendix with numerous adhesions pulling downward and outward on the duodenum.

5. Ulcer not confirmed clinically, not confirmed by X-ray, not found at operation, three cases. Two of these cases showed retrocecal appendices with wide spread adhesions in region of cecum and ascending colon. The third case showed the same thing with a markedly dilated cecum adding weight to the pull of the adhesions; this cecum was plicated and fixed to abdominal wall.

Other cases simulating gastric or, more commonly, duodenal ulcer, either clinically or by X-ray study or both, but by persistent study finally diagnosed accurately and properly treated:

(1) Adhesions from gall bladder, cleared up by gall bladder visualization.

(2) Supra-mesocolic periduodenitis with membranes and bands.

(3) Duodenal diverticula.—One case gave at one time typical symptoms of duodenal ulcer, at another of cholecystitis, at another colitis with gas, soft stools or diarrhœa with mucus. This case was diagnosed by Doctors Lafferty and Phillips and Doctors Shull and Fetner, local röntgenologists, as spastic colitis; by Dr. Fred Baetger of Baltimore, appendicitis with duodenal spasm; by Dr. Pancoast of Philadelphia, adhesions from cholecystitis, and the following are the conclusions of Lewis Gregory Cole after a most elaborate and protracted X-ray study:

"From a study of those röntgenograms, I believe one is justified in making a negative diagnosis of cancer and ulcer of the stomach and a negative diagnosis of ulcer of the cap. There is no pyloric stenosis, no functional gastric retention—in fact, the stomach empties more rapidly than usual. There is apparently some irritation, as there is considerable tendency to spasm of the cap and at times, the peristalsis of the stomach is exceptionally vigorous."

"There is a diverticulum of the first part of the descending duodenum." (This diverticulum was never found before in the several X-rays taken. Was it acquired or was it always present during these former studies?) "This lies to the left of the duodenum and apparently anterior to, and in close relation to, the junction of the common bile duct and pancreatic duct.'

"I find no evidence of calcified gall-stones. The gall-bladder did not fill with the dye, although this was given orally on two successive days. In our experience this is quite positive evidence that the gall-bladder is diseased."

(What relation does the diverticulum bear to failure of the gall-bladder to fill? Located as it is in close relation to the junction of the common bile duct and pancreatic duct, what would be the difficulties of satisfactory removal at this location and if removed the chances of further obstructing the ducts, and, finally, what are the dangers of such diverticula beyond a causative agent in the patient's discomfort?)

"I believe one is justified in making a negative diagnosis of a diverticulosis of the lower descending colon and the sigmoid colon. There is no evidence of diverticulitis. The appendix is patent, almost six inches long, and apparently contains several small fecaliths. I would consider this a pathological condition of the appendix but I do not believe it is by any means

a surgical condition. There is apparently a congenital veil or band of adhesions in the right hypochondrium which involves but does not obstruct the hepatic flexure of the colon."

(This patient with unfilling gall-bladder, duodenal diverticulum, pathological appendix and hepatic adhesions remains unoperated on, relieved of the fear of perforating ulcer and ruptured appendix. What surgeon could resist operation on this case!)

A second case, sixty-eight years old, who forty years ago had several attacks of pain, nausea, gas and soft stools which was diagnosed "bilious colic," for he was given calomel and relieved. During such an attack eighteen years ago, he overheard the uncertainty of diagnosis and suggestion of exploratory operation made by the consulting surgeons and he left the hospital. To this day he occasionally has a little nausea and soft stools, quickly relieved after an oil purge. His physical findings are practically negative. X-ray studies showed that there is present a diverticulum involving the terminal portion of the duodenum which is smooth in outline, freely movable and not tender to palpation; and the barium meal was seen to enter and leave the diverticulum during fluoroscopic examination. The six hour picture shows a small residue in the diverticulum after the stomach and duodenum had emptied.

(4) Duodenal obstruction.—Eleven cases, ten operative. Diagnosis missed in one case.

(a) Due to inframesocolic adhesions, five cases. The diagnosis was suspected clinically and made by X-ray study in all five cases.

Three of these cases were relieved by duodenojejunostomy and one by gastroenterostomy after taking down the duodenojejunal angle and one by liberating the periduodenal adhesions.

(b) Due to compression of the arterial pedicle, two cases. One relieved by duodenojejunostomy, the other by postural treatment both during acute attacks and afterwards.

(c) Due to diverticulum near duodenojejunal junction by removal of diverticulum.

(d) Due to developing obstruction from periduodenitis and ulcer below the bulb, with hæmorrhage from ulcer, relieved by gastroenterostomy.

(e) Due to nephocoloptosis: Relieved by the Longyear operation. Second case relieved by resection of prolapsed megalocecum and ascending colon.

It will be noted out of the fifty cases cited above that the diagnosis was suspected clinically fifty times and confirmed by X-ray study and operation or both forty-two times; and that the X-ray study corresponded with the clinical impression and operation forty times. In other words the clinical diagnosis was 84 per cent. accurate and the X-ray study was 80 per cent accurate.

In the group, "other cases simulating gastric and duodenal ulcer," the X-ray study was about 90 per cent. accurate and cleared up a very speculative clinical impression. Of the eleven cases ten were accurately diagnosed and ten confirmed by operation and markedly relieved. These data in sixty-one cases would indicate that an accurate diagnosis, by employing history, clinical and X-ray studies, can be made in 84 per cent. of cases of ulcer and cancer of the stomach and ulcer of the duodenum (fifty cases) and in ninety of

duodenal obstruction. That a presumptive diagnosis where either clinical or X-ray examinations are at variance can be made in about 87 per cent. of cases. That an accurate diagnosis cannot be made from the combination in about 13 per cent. of the cases and that the gall-bladder, appendix, diverticula, periduodenitis and arterial compression of the duodenum will usually explain the condition in these cases. The following operations have been employed in these 108 cases:

(a) *Gastroenterostomy.*—In about 30 per cent. of these cases there has not been complete relief of symptoms. Most of the stomachs in those not relieved have emptied very rapidly, at times about as rapidly as the barium could be given and there has been complaint of diarrhœa and gas and some nausea and vomiting. One case particularly who had a gastric retention and markedly dilated duodenum, received the anastomosis at the duodenojejunal junction, after severing the ligament of Trietz and her stomach and duodenum empty as fast as the barium can be swallowed, faster than after a gastric resection, she still has attacks of nausea and voluminous vomiting. One case died two years later of carcinoma of the stomach not found at operation and therefore not resected. There has been no recurrence of hæmorrhage, no perforation and little or no pain in the epigastrium or right hypochondrium after these gastroenterostomies.

(b) *Gastroenterostomy.*—After resection of the ulcer. These patients have been free of symptoms except those due to too rapid emptying of the stomach. One case died on the table after separation of the ulcer from the pancreas with resection of the ulcer and closure of the pancreas. This was the case of rheumatism with a once decompensated heart.

(c) *Pyloroplasty and resection of the ulcer.*—All these cases have been completely relieved and remain symptom free except two cases, where the ulcer has recurred; one having recurrence of hæmorrhage, the other a perforation. Both of these cases studied after the first operation, showed considerable dilatation of the duodenum, which dilatation and partial obstruction, I think contributory in the re-formation of ulcer. At the second operation for perforation, the cauterization and closure of the perforated ulcer was followed by gastroenterostomy. This I have done several times when the duodenum through closure was markedly encroached upon, with perfect result. I feel sure that in case of dilated duodenum and perforation a duodenojejunostomy would prevent recurrence of these ulcers if this operation were practicable at the time or later on. X-rays following pyloroplasties are most confusing.

(d) *Resection of pylorus or stomach and type of Billroth No. 2.*—Two of these resections have been done for ulcer of the stomach, one showing carcinoma on ulcer base. They are both perfectly well. Seven have been done for carcinoma of the stomach, two dying in fourteen and eighteen months respectively from metastasis, the other five cases comfortable and in good health. These cases eat full meals, show a compensatory dilatation of the remaining stomach and control of emptying at the anastomosis between stom-

ach and intestine equal to if not more effective than 30 per cent. of the gastro-enterostomies.

(*e*) *Resection of ulcer.*—Only in three cases have I simply resected the ulcer without combination with pyloroplasty or gastroenterostomy, except in cases of acute perforation, and even in these cases of acute perforation, those combined with gastroenterostomy, thus also relieving causative conditions and offering free drainage, of the stomach have done best. In many cases with dilated duodenum and ulcer, duodenojejunostomy preceding resection would serve the purpose better than gastroenterostomy.

(*f*) *Duodenojejunal anastomosis.*—In six cases of obstructed and dilated duodenum, due to fixed obstruction at the last portion of duodenum or duodenojejunal junction, I have seen no more brilliant results in the whole domain of surgery than the relief, if not cure, brought about by duodenojejunostomy, except in the one case, where through my enthusiasm in relieving obstruction I did an anastomosis between the liberated duodenojejunal angle and the stomach. This is the case cited above with the extremely rapidly emptying stomach and duodenum, so extreme until the coils of the small intestine are made to take too voluminously the onrush of stomach contents with a resulting reverse peristalsis felt from cæcum upward and vomiting. Three more cases of duodenal obstruction were relieved by resection of a ptosed megalocecum and ascending colon, Longyear's suspension of the kidney, and removal of a diverticulum at the duodenojejunal junction. Still a final case of arteriomesenteric obstruction of the duodenum was immediately relieved of pain and voluminous vomiting by merely turning her on her stomach and elevating the foot of the bed.

(I shall elaborate deformities and obstruction of the duodenum in another paper.)

(*g*) *Duodenostomy.*—One case to give rest to the stomach and for duodenal feeding in a case of linites plastica, where the passage of a duodenal tube was impossible on account of the thickened and contracted stomach.

(*h*) Other operations, on account of mistaken diagnosis, such as appendectomy and cholecystectomy, usually with relief.

It is rather definitely clear from the above remarks under operative procedures that the best results have been obtained where the ulcer or cancer was resected and where obvious obstructive conditions of the stomach and duodenum have been relieved by proper drainage of the canal, necessary even after resection of the ulcer.

About a half of a century has elapsed since the foundation of gastric operations and yet hardly a single revolutionary method has been developed since that time. Technical modifications and improvements have been exposed, but the principles ,of enlarging the pyloric orifice as laid down by Heineke-Mikulicz, the gastrointestinal anastomosis of Woelfer and the gastric resections of Billroth remain the basal procedures. It is likely that none of these operations or their modifications has more than a mechanical action beyond the removal of the growth and that no enduring physiological basis

has been developed beyond the drainage of the higher into the lower portion of the gastrointestinal tract and that this principle of relieving stasis satisfies all surgical requirements and gives when clearly indicated satisfactory results.

In support of this last statement are the far more brilliant results in obstructive cases of ulcer and cancer, by gastroenterostomy, even when the emptying of the stomach is far too rapid and the remarkable results of duodenojejunostomy in duodenal obstruction. A number of the cases of ulcer of the duodenum with dilatation of the duodenum would likely be more effectively and permanently relieved by duodenojejunostomy, preceding resection of ulcer or pyloroplasty or following closure of perforated ulcer of duodenum, and in case of recurrence of duodenal ulcer and perforation. The substitution of duodenojejunostomy for gastro-enterostomy would drain the dilated duodenum, preventing stasis and pressure, more directly and preclude the too rapid drainage of the stomach, and thus prevent the untoward results of gastroenterostomy.

(The choice between gastroenterostomy and duodenojejunostomy will be pointed out in more detail and with more definite indications in a paper on "Deformities and Obstruction of the Duodenum" and Duodenojejunostomy.)

A more vital question even than the choice of the proper operation is the question whether or not to operate at all.

If we can take Cole's word for it, practically all ulcers of the stomach occur in the corpus and antrum, along the lesser curvature and all these ulcers are benign; all duodenal or post-pyloric ulcers are benign. In thirty-six consecutive cases of corporic ulcer, all healed without perforation, and in only one instance could the second ulcer have been a recurrence rather than a new ulcer. In every instance where a malignant ulcer developed, the subsequent ulcer healed under medical treatment with as great or even greater rapidity than the original ulcer. On the other hand one of these cases perforated three days after the third Sippy treatment of eight weeks each and an ulcer the size of a half dollar with perforation size of a dime was found in antrum on anterior surface. He has remained well three years after cauterization closure of ulcer and gastroenterostomy. This was a benign ulcer.

Cole further concludes that any ulcer that increases in size after the initial avulsion of the crater should be considered malignant or at least not a simple or benign type of ulcer; and ulcers that occur nearer the greater curvature than the lesser should be considered ulcerations in carcinomatous areas and not benign ulcers. In the case just cited the large ulcer located on the anterior wall of antrum near the pyloric canal never healed, was not obstructive, perforated and remains well three years following cautery excision, closure, gastroenterostomy. Therefore with ulcer outside ulcer area, he should have received gastrectomy before perforation. Two other cases with ulcer in this region and where gastrectomy was done were carcinoma and a fourth case of a man fifty-two years old with persistent vomiting, extreme reduction in weight and color, with large mass nearer lesser curva-

ture but almost entirely obstructing stomach, and glands along lesser curvature, a palliative gastroenterostomy was done with diagnosis of inoperable cancer. Two years later, with a gain of sixty pounds, this man came by to thank me for his cure. At operation one of the glands along lesser curvature should have been removed for examination by frozen section as aid in diagnosis between inflammatory gland and metastatic gland.

Cole reports eleven cases of corporic ulcer treated with gastric resection; six lived to leave the hospital and five died while in the hospital. Of the nine cases of gastrectomy reported in this paper, all left the hospital, two dying, after a year, of metastasis. All have maintained a satisfactory gastric function, even the ones who died. Why this enormous difference in mortality?

The following conclusions in projecting operation are justified:

(1) All ulcers occurring in the antrum and corpus along the lesser curvature are benign.

(2) All ulcers outside this ulcer zone are malignant.

(3) Obstructive ulcers along the lesser curvature showing inflammatory lymph glands may heal without gastrectomy.

THE END RESULTS IN FIVE HUNDRED CASES OF CHOLECYSTECTOMY*

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A certain amount of confusion and chaos has existed in the minds of the laity and many physicians regarding the benefits derived from the removal of the gall-bladder. This study has been made in order to evaluate the results obtained after cholecystectomy. During the last eight years, 1800 cases of cholecystitis, recorded either as a primary or secondary diagnosis, have been examined in The Polyclinic. About 30 per cent. of the patients have been operated on. Many others were advised to avail themselves of surgical treatment but for various reasons declined.

Clinical Data.—A wide variation of ages may be noted in this series. The youngest patient was a girl, aged four years, who was brought to the clinic on account of abdominal pain, with nausea and vomiting, of three days' duration. A mass that was interpreted as the result of intussusception was found in the right upper quadrant of the abdomen. At operation this proved to be a large cystic gall-bladder without stones. After cholecystectomy recovery was prompt and the child has remained well more than six years. The oldest patient was a woman, aged eighty-three years, who had been ill at intervals for more than forty years. The acute cystic gall-bladder, about twenty centimetres in length, presented as a large tumor extending down to the brim of the pelvis. After cholecystectomy under local anæsthesia the patient's recovery was rapid and satisfactory. She has been in good health more than two and a half years. The average age of the series of 500 patients operated on was forty-three and eight-hundredths years. This is in contrast to reports several years ago when the average age was much more. With the increase in diagnostic accuracy, more and more cases of disease of the gall-bladder will be found in young persons.

Sixty-nine per cent. of the series were females and 31 per cent. were males. Deaver's adage of "female, fair, fat and forty" as suggestive of cholecystitis has much truth in it. Pregnancy probably plays a definite part in the etiology of the disease. The average weight was 145.5 pounds. Many of the patients weighed less than 100 pounds.

Epigastric pain of some degree, such as fullness, gas or bloating, was the chief complaint in 78.2 per cent. "Bilious" or gall-stone colic was noted in 59.2 per cent.; however, stones were found in only 40 per cent. of the gall-bladders removed, showing that typical attacks of pain may be precipitated in many cases of non-calculus cholecystitis. Qualitative food dyspepsia was noted frequently and when present was a valuable symptom in the diagnosis of cholecystic disease. A history of jaundice was obtained in 23 per

cent. In forty cases (8 per cent.), the complaint was indefinite and in no way related to the gall-bladder; the finding of cholecystic disease was entirely incidental during the course of a thorough examination. Nausea and vomiting occurred in only 255 cases (51 per cent. of the series). Prompt relief was usually obtained by emptying the stomach, but in most instances the pain returned in a short time.

There are many minor complaints that may be valuable in the final summing up of all the clinical evidence entering into the diagnosis of disease of the gall-bladder, but there are only a few real essential high points as we have observed them. In the final analysis, we have a keen realization that ultimately the diagnosis of cholecystitis and the final disposition of the case must rest primarily in the hands of the clinician.

The surgeon is often perplexed to know whether or not a gall-bladder should be removed. The pathologist may sometimes find only slight evidence of disease in a gall-bladder that had been removed on the clinician's recommendation on account of symptoms sufficient to warrant such a procedure. The röntgenologist by cholecystographic means may detect a poorly

TABLE I

500 GALL-BLADDER OPERATIONS
Showing extent of operative procedure

Type of Operation	No. of Cases	Per Cent.
Cholecystectomy only	178	35.6
Cholecystectomy and Choledochotomy	29	5.8
Cholecystectomy and Appendectomy	245	49.0
Cholecystectomy and G. E. or Pyloroplasty and Appendectomy	48	9.6

functioning gall-bladder in a patient without complaint sufficient to justify cholecystectomy. He may also demonstrate good function in the presence of a complaint, and surgical and pathologic evidence sufficient to warrant the removal of the organ. In my experience, especially in the doubtful case, the acid test of whether or not a gall-bladder should be removed is the clinical history. Most of the surgeon's disappointments in the end result are related to cases in which there are cholecystographic evidence and surgical indications for operation but not a good clinical history.

Operative Procedure.—In the past, incomplete operation and often failure to remove intra-abdominal lesions have been causes of poor end results in many instances. In this series of cases it was necessary to do multiple operations in a large percentage of the cases, and therefore it may seem unfair to attribute all of the satisfactory end results to the removal of the gall-bladder. However, only those cases have been included in which the gall-bladder was considered the primary disease. The gall-bladder was removed only in 178 cases (35 per cent.). In most of them the appendix had been removed previously, or it was not considered sufficiently diseased to warrant its removal. The common bile duct was opened in thirty-three cases. The appendix was removed secondarily in 238 cases (47.6 per cent.).

When the appendix is present, and if it shows any degree of disease, it is our custom to remove it through the same incision. In forty-eight cases (9.6 per cent.), duodenal ulcer was found either before or during the operation. In each case gastro-enterostomy or some type of pyloroplasty was done besides cholecystectomy and appendectomy. Early in the series the combined operations were done with some hesitation but now with added experience and satisfactory end results, we feel perfectly safe and usually justified in doing the additional work. In practically all cases the entire operation has been completed within one hour. Here again the good end results may be influenced by the operations of the stomach and on the appendix. However, the gall-bladder was apparently the more severely diseased and clinically the chief offender. The main point to be emphasized is the complete eradication of all intra-abdominal disease.

From time to time over a period of many years, various surgeons have reported cases in which the gall-bladder had been removed and the abdomen

TABLE II

500 GALL-BLADDER OPERATIONS SHOWING THE RELATIVE PROPORTION OF CASES WHERE THE ABDOMEN WAS CLOSED WITH DRAINAGE AND WITHOUT DRAINAGE

Type of Operation	Abd. Drained	Abd. Not Drained	Per Cent.	Deaths	Per Cent.	Remarks
G. B. operation alone or combined with other upper abdominal operations	328		65.6	20	6.09	Chief cause of death pneumonia, myocardial and hepatic insufficiency
Cholecystectomy alone or combined with other upper abdominal operation		172	34.4	0	0	One patient died of suppurative parotitis 15 days P. O. Abdominal wound healed O. K.
Mortality for entire series of 500				20	4.0	

closed without drainage. Few, however, have reported a large series of cases. In our early work the abdomen was closed only in cases in which diabetes was present and it was desired to prevent infection of the abdominal wall and promote primary healing. The fear of leakage of bile into the peritoneal cavity had been the deterring factor in practically all cases. In a large group of cases in which infection is present, the tissues are soiled on account of the spilling of the bile and infected fluids during the removal of the gall-bladder, and often a certain amount of oozing of blood makes a dry operating field well nigh impossible. All agree that drainage should be carried out in such cases. About five years ago we began to close the abdomen without drainage in a selected group of clean cases, in which the field was dry and a minimal amount of trauma had occurred during cholecystectomy. As time went on, we extended the indications for such closure and now tight closure is made in more than 70 per cent. of cases. In this series, drainage was instituted in 329 cases (65.6 per cent.). The ducts were opened in thirty-three of them and bile came to the surface. A careful check of the

records of the hospital disclosed only ten cases in which bile was found on the dressing when simple cholecystectomy was performed and the ducts were not opened. In less than 3 per cent. bile drained. In two of the cases, after removal of the tubes, there was an accumulation of bile about the stump of the cystic duct several days after the wound had healed, which necessitated the reopening of both wounds and the evacuation of a large amount of infected fluid. Both patients recovered.

In 172 cases (34.4 per cent.) the abdomen was closed without drainage. It was not necessary to reopen the abdomen in a single case nor had there been evidence of leakage of bile into the peritoneal cavity. As a general rule the convalescence was easier, smoother and shorter when drainage was not used than when it was. If drainage was used the patients remained in the hospital an average of sixteen and five-tenths days; if it was not used, fourteen and six-tenths days. The wound was infected in forty-six (14 per cent.) of the former, whereas only eleven (6.4 per cent.) of the latter were infected.

Of the 328 patients whose wounds were drained, twenty (6.09 per cent.) died. They were generally poorer risks. The chief causes of death were

TABLE III

500 CHOLECYSTECTOMIES SHOWING NUMBER OF HOSPITAL DAYS AND CONDITION OF WOUNDS IN THE DRAINED AND UNDRAINED CASES

	Drained Group		Undrained Group	
	Cases	Per Cent.	Cases	Per Cent.
Cholecystectomy with or without opening ducts.....	328	65.6	172	34.4
Number of infected wounds......................	46	14.0	11	6.4
Number of cases drained bile P. O................	43	13.1	0	0
Average hospital days...........................	16.5		14.6	

Ducts were opened in thirty-three of the drained group. Only ten cases drained bile after simple cholecystectomy.
No case in the undrained group showed evidence of bile leakage into the peritoneal cavity.

noted as pneumonia, and myocardial and hepatic insufficiency. One patient died on account of an embolism at the bifurcation of the abdominal aorta. Embolectomy was not done. The wound broke open in two other cases and both patients died following resuture of the wounds. There was no death which could be attributed to closure without drainage in the 172 cases of this group. One patient died on the fifteenth post-operative day. Double suppurative parotitis developed. Both parotid glands were opened and drained. A retropharyngeal abscess later formed and death was apparently due to meningitis. The mortality in the entire series of 500 cases was 4 per cent.

The problem of whether to drain or to close the abdomen tight after cholecystectomy is more or less contingent on accessory bile ducts and the peace of mind of the surgeon, except in the infected cases in which all agree as to the use of drainage. Moynihan stated that he closed the wounds in many cases without drainage when he was young and adventurous but now he drains in all cases after removal of the gall-bladder. At his request, Flint

studied 200 cases at necropsy to determine the incidence of accessory bile ducts and he found them present in 14.5 per cent. of the cases. I have seen accessory ducts in only two cases. Bile drained around the tube while the abdomen was being closed. In one instance, the abdomen was reopened, the cystic duct was found securely tied and the bile leaking from a small accessory duct. It ceased to flow in a day or two and the wound healed primarily. When the cystic duct and artery are clamped and tied together there seems to be less danger of leaving an open duct. This has been my custom.

Pathology.—The hospital records were carefully searched in all of the cases in this series. The pathologic report was tabulated in 486 of the cases. The cases have been graded into four main groups depending on the extent of the lesion. Grade I represents a mild degree of cholecystitis and grade IV represents the most severe condition, the gall-bladder being functionless, the walls thick and usually the cystic duct occluded. Grades II and III represent intermediate states, both showing rather marked evidence of disease. Only twenty-eight (5.8 per cent.) of the entire series were graded I.

TABLE IV

PATHOLOGICAL REPORT. GRADED I TO IV DEPENDING ON EXTENT OF LESION
(*486 cases reported on by pathologist*)

	Grade	No. Cases	Per Cent
Cholecystitis..	I	28	5.8
Cholecystitis..	II	229	47.0
Cholecystitis..	III	176	36.6
Cholecystitis..	IV	51	10.5
Cholecystitis with stones...........................		192	40.0.
Cholecystitis (Strawberry).........................		49	10.0
Cholecystitis (Acute)..............................		22	4.5

Usually there was some question in the surgeon's mind about the indication for cholecystectomy in this group. When the clinical history was suggestive of cholecystitis, the surgeons would not hesitate to remove the organ. It may be noted that the "no relief" group in the follow-up study corresponds in the main to the group graded I. It is our observation and belief that the extent of the disease of the gall-bladder bears a definite relation to the end result after cholecystectomy. Formerly a large percentage of the gall-bladders removed had gone on to a stone-forming stage. Stones were present in 192 (40 per cent.) of this series. More stones were found in the cases graded III and IV than in those graded I and II. As time goes on and gall-bladders are removed earlier in the disease, it is probable that fewer stones will be found. The so-called strawberry gall-bladder was found in forty-nine cases (10 per cent.). Stones were present in several of them. It has been our observation that practically all diseased gall-bladders that produce symptoms are inflamed. The strawberry gall-bladder may be an exception. The lipoid infiltration of the mucosa may or may not be a disturbance of cholesterol metabolism that alters the function of the organ.

Many years ago Virchow called attention to such a possibility. We have observed that some of our worst cases clinically, even accompanied by severe attacks of colic, have been of this variety. Apparently there is a great tendency to myocardial involvement during the course of this disease. The relief has been most striking after the removal of the strawberry type of gall-bladder.

A carefully prepared questionnaire was mailed to each patient. They were asked to state: (1) whether or not they had obtained relief from the symptoms for which the operation was performed; (2) whether there had been improvement of the digestive disturbance; (3) what the condition of the wound was relative to a bulge or hernia; (4) recurrence of colic, if any, and (5) if they had been jaundiced since the operation.

Twenty patients died in the hospital and eighteen died later from other causes. Thirty questionnaires were returned unclaimed and eighty patients could not be traced. Two hundred seventy-six responded to the questionnaire and seventy-six others were either recently reëxamined at the clinic

TABLE V. FOLLOW-UP STUDY OF 500 CHOLECYSTECTOMIES
FROM 1921 to 1928, INCLUSIVE

20 died in hospital
30 questionnaires returned unclaimed
18 died later from other causes
80 could not be traced
276 responded to the questionnaire
76 were either reëxamined or condition known by personal observation
352 known cases form the basis of this study

or their conditions were known by personal observation. The follow-up study is therefore based on 352 traced cases.

The benefits obtained as related to questions 1 and 2 were classified into complete, partial and the no relief groups. I was surprised to find that 269 (84 per cent.) of the patients were completely relieved of the symptoms for which the operations were performed. As has been mentioned, other diseased organs besides the gall-bladder were removed in many instances. This may have favorably influenced the end results in many cases. Forty-two patients (11.6 per cent.) reported only partial relief but were improved. Only fourteen (4 per cent.) were not benefited.

It was gratifying to note that the digestion was greatly improved in 306 cases (87 per cent.). Only partial relief was obtained in thirty-three cases (9.3 per cent.). Thirteen of the entire group (3.7 per cent.) were not relieved or were made worse.

The condition of the wound was satisfactory in 91.5 per cent. of the cases whereas a bulge or hernia occurred in thirty (8.5 per cent.) of the entire group. The incidence of post-operative hernia was far greater in cases in which the wounds were drained than in cases in which they were not drained. Strangely enough, practically all the hernias that occurred were

in the cases in which operation had been done through an upper right rectus incision with the rectus muscle retracted to the outer side. Hernias through such wounds are far more difficult to repair than if the rectus fibres have been separated in the usual muscle-splitting type of operation.

Eighty-seven and two-tenths per cent. of the patients did not have colic after the operation whereas 12.5 per cent. reported having had one or more spells of "bilious" colic. The pain was similar to the former spells and in practically all cases the patients were afraid of the return of the original trouble. After the colic had subsided there was no jaundice in most cases and the progress was then as smooth as it was in the uncomplicated cases. In two cases stones were later found in the common bile duct and a secondary operation was necessary. In the remaining number it was not possible to determine the cause of recurrent pain in the absence of any apparent unremoved lesion.

TABLE VI

FOLLOW-UP STUDY OF 500 CHOLECYSTECTOMIES SHOWING
SUBSEQUENT STATE OF HEALTH
(*352 cases heard from and form the basis of this study*)

	No. Cases	Per Cent.
Complete relief of symptoms for which operation was done..........	296	84.0
Partial relief of symptoms.....................................	42	11.6
No benefit or made worse......................................	14	4.0
Digestion much improved......................................	306	87.0
Only partial relief	33	9.3
Digestion not benefited or made worse..........................	13	3.7
No colic..	307	87.2
Recurrent colic..	45	12.5
No subsequent jaundice.......................................	336	95.4
One or more attacks of jaundice...............................	16	4.5
Condition of wound O. K......................................	322	91.4
Bulge or hernia..	30	8.5

Sixteen patients (4.5 per cent.) reported the appearance of post-operative jaundice of some degree. This could be accounted for in two cases by the finding of stones in the common bile duct but in the others the cause was less certain. The icterus soon disappeared and did not leave any bad after effect.

A review of published reports of the last several years was made to ascertain how nearly our observations correspond with those of others.

Thirteen series of cholecystectomies (those of Cave,[1] Clark,[2] Danzis,[3] Davis,[4] Fallon,[5] Hitzrot and Cornell,[6] Hueck,[7] Iselin,[8] Johnson and Pearre,[9] Judd and Parker,[10] Lahey,[11] Marks,[12] Verbrycke [13]) in which the operative mortality is noted present an aggregate of 4032 cases, a mortality of 191 (4.73 per cent.). Iselin reports a series of 100 cholecystectomies, including eight in which drainage of the common bile duct was also done, without a death; Marks, a series of seventy-five without a death.

Cause of Death.—Peritonitis, pneumonia, bronchopneumonia and shock

were the chief causes of the thirty-seven deaths in the hospital in Hitzrot and Cornell's [6] 400 cases. Cardiac failure accounted for five of the twelve deaths in Johnson and Pearre's [9] 192 cholecystectomies. Cardiac disease, peritonitis, hæmorrhage, pulmonary embolism and bronchopneumonia were responsible for two deaths each, in the twelve deaths among 845 simple cholecystectomies reported by Judd and Parker.[10] Cave [1] reports pneumonia, hæmorrhage, peritonitis, pulmonary embolism and immediate hyperpyrexia as the main causes of the thirty-two deaths in his series of 470 cholecystectomies. The hyperpyrexia, he believes, was due to absorption of diseased or chemically altered liver cells or toxic bile.

In thirteen series (Cave,[1] Clark,[2] Dahl-Iversen,[14] Danzis,[3] Davis,[4] Fowler,[15] Lahey,[11] Hitzrot and Cornell,[6] Hueck,[7] Johnson and Pearre,[9] Marks,[12] Seulberger,[16] White and Riddick [17]) showing late results, 2,222 traced cases are represented. One thousand six hundred ninety-nine patients, or 76.4 per cent. are reported as well; 321 (14.5 per cent.) as improved, and 145 (6.5 per cent.) are unimproved. When we attempt to compute mathematically with such conceptions as "well," "improved," and "unimproved," determined on a basis of symptoms, we enter a region of quicksands, and, arrived on the other side, we feel entirely uncertain as to how much of the truth we have succeeded in carrying over. The figures of the individual series vary so widely that one suspects that differences in wording the questionnaires and in evaluating the answers are partly responsible for the differences. It may be noted, however, that in seven of the reports the percentage of patients well after the operation is in the eighties; in one, in the nineties.

Several of the authors think that errors of diagnosis should bear the blame for the greater part of their failures. White and Riddick [17] believe that too much stress was laid on the X-ray findings. Judd [18] notes that the diagnosis was not definite in most of the failures among his cases of mild cholecystitis.

Pathology of Gall-bladders Removed.—Davis'[4] series was about equally divided between cholecystitis with and without stones. The group with stones gave better end results. Hadley's [19] and Hitzrot and Cornell's [6] series show the same advantage on the side of calculous cholecystitis. Hueck's [7] series shows a trifling advantage on the side of cholecystitis without stones. Judd [18] saw the best late results in strawberry gall-bladders with stones (96 per cent. good results), nearly as good (93 per cent.) in severe cholecystitis (grades II, III and IV) with stones. In the same conditions without stones, operation gave good results in 87 and 88 per cent., respectively, while in mild cholecystitis (grade I) the percentage of good results was 84.4. In Seuberger's [16] series only 82 per cent. of the gall-bladders in the group of patients not freed from symptoms had presented actual disease at operation, whereas the group freed from symptoms by the operation had shown severe changes in the gall-bladder in 96.3 per cent. In the former group the patients were younger and the duration of the disease before operation was shorter than in the latter group. Eighty-eight per cent. of the gall-bladders

TABLE VII

SUMMARY OF CASES REPORTED BY THE FOLLOWING AUTHORS DURING THE PAST EIGHT YEARS
SHOWING THE END RESULTS AFTER CHOLECYSTECTOMY

Author	Cases	Traced	Per Cent.	Well	Per Cent.	Improved	Per Cent.	Not Improved	Per Cent.	Deaths	Per Cent.	Not Drained
Cave	470	209	44	182	86.1	21	10.0	6	2.8	32	15.3	22
Clark	108	102	94	82	80.2	17	16.6	3	2.2	5	4.6	—
Dahl-Iversen	146	146	100	126	86.3	11	7.0	19	12.0			—
Danzis	113	113	100	90	80.0	8	7.1	8	7.1	5	4.3	—
Davis	156	144	92	100	69.4	38	26.4	6	4.2	4	2.7	—
De Courcy (Lahey)	64	64	100	51	80.0	6	9.3	3	4.5	4	6.2	—
Fallon	800	800	100		—				—	37	4.6	—
Fowler	422	422	100	396	93.8	13	3.0	12	2.8			—
Hitzrot and Cornell	400	384	96	203	52.8	107	28.0	30	7.5	37	9.6	—
Hueck	263	135	51	89	65.8	26	19.3	20	14.9	19	14.0	—
Iselin	100	100	100		—							—
Johnson and Pearre	192	120	62	72	60.0	45	37.5	3	2.5	12	6.25	—
Judd and Parker	989	989	100		—					15	1.5	—
Marks	75	56	75	38	67.85	14	25.6	4	7.0			13
Seulberger	304	217	72	180	82.09	6	2.0	20	9.0			—
Verbrycke	302	302	100		—				—	21	6.9	—
White and Riddick	200	110	55	90	82.0	9	8.0	11	10.0			—
Sanders	500	352	70	296	84.0	42	11.0	14	4.0	20	4.0	172

in Marks'[12] series were grossly pathologic; nine (14.5 per cent.) were grossly normal, but the histories were typical for gall-bladder disease. Microscopic examination showed mild chronic inflammation in seven of these. Seven of the nine patients concerned were heard from; four were symptom-free, two were improved, one was unimproved. Palpable stones were present in 65 per cent. of the entire series. Chronic cholecystitis with stones was found in just over half the cases; the same without stones in 21 per cent.; stones without changes in the gall-bladder in 23 per cent. Wideröe[20] found stones at 90 per cent. of his interval operations, at 65 per cent. of his operations performed during the attack.

Digestion.—Indigestion for certain foods occurred in 19.8 per cent. of Marks'[12] cholecystectomized patients; in 8.9 per cent. the intolerance was to fat. Mild irregularity in digestion was noted in 10.7 per cent.

Agrifoglio[21] made a series of experiments on dogs and demonstrated decreased utilization of fats—chiefly soaps and fatty acids—after loss of the gall-bladder. This decrease did not set in at once, but within ninety days. After from ten to fifteen months the utilization of fats, except soaps, improved.

The question of gastric acidity comes into the problem of digestion after cholecystectomy. Popper[22] and Seulberger[16] have made observations on this point. Popper tested the gastric juice of more than one hundred persons, some earlier and some later than one and a half years after removal of the gall-bladder. He found that the operation did not have the effect of decreasing acidity except in cases with severe inflammatory complications. Seulberger's studies, made on groups of patients before and after cholecystectomy, indicate, likewise, that deprivation of the gall-bladder does not lower gastric acidity. In the group of patients not definitely freed from symptoms, the percentage with subacidity and anacidity was much higher both before and after operation than in the patients whose symptoms became entirely relieved, but the operation did not raise the percentage in either group. Seulberger's acidity studies were carried out on only about one-third of the total number of patients in each group. Analysis of the groups in their entirety showed that 27 per cent. of this group not freed from symptoms had poor digestion for heavy foods, whereas among the 180 patients whom the operation had freed from the symptoms for which it was undertaken only one had any digestive trouble—difficulty in digesting fats. Johnson and Pearre[9] found that indigestion, gas and constipation were the symptoms most often unrelieved.

Colic and Jaundice.—The question of the return of colic was studied by Hueck.[7] In 14.9 per cent. of his series of 135 patients colics persisted at the time of the reëxamination, from two to twelve years after operation. A further 6.6 per cent. had had colics since the operation, but had them no longer. His analysis showed recurrence of colic to be independent of the type of lesion, of the age of the patient, and of the time of operation, whether early or late. The colics may be localized in the biliary tract or in the stomach or intestine and he believes they are phenomena of nerve

disturbance. Judd [18] found colic and jaundice in 75 per cent. of his poor results in cases of chronic strawberry gall-bladder without stones, in 33 per cent. of his poor results in cases of severe cholecystitis without stones, and in 100 per cent. (two cases each) of the same conditions with stones. Marks [12] reports three cases of jaundice in sixty-seven replies.

Question of Post-operative Drainage.—While the question: to drain or not to drain, has been the subject of heated argumentation, particularly in the European medical press, I have seen only three series of considerable size comprised wholly of undrained cases. Verbrycke [23] reports eighty-six consecutive cases of closure of the abdomen without drainage after cholecystectomy. There were no deaths. He analyzes thirty of these cases as to late results: No symptoms after operation, twenty-one cases; improvement, five; death (carcinoma of the pancreas), one; untraced, three. Fowler [15] published a series of eighty-one cases in which closure without drainage was practiced. There were two post-operative deaths. He compares the results in sixteen of these cases, on which he had a report one year or more after operation, with a series of 406 cases with post-operative drainage, reported on after a similar interval. In the non-drained group the results were: complete relief, 70 per cent.; fair result, 19 per cent.; no relief, 11 per cent. In the drained groups: complete relief, 94.8 per cent.; fair result, 2.48 per cent.; no relief, 2.7 per cent. Richter [24] has been closing the abdomen without drainage more than twelve years and is more and more enthusiastic about it with added experience. He has been widening the indication for such practice as experience has justified it. In his last series of 100 cases, eighty-three were closed tight. He reports having closed 204 cases without a death that could be attributed to the method. He does not think bile leakage occurred in any of them. He has been bold enough to close the abdomen tight after opening the common duct. He infers that the end result is better and the mortality less in all cases where the method is suitable. Davis [4] does not give his figures, but states that he believes that in the average case the wound may safely be closed tight and that the end results are better when this is done.

Comment.—The results of this study have been very gratifying. It has shown better end results than were anticipated. Valuable lessons have been learned about the proper selection of cases for surgical treatment. The clinical data ascertained and properly interpreted by the clinician constitute the most important factor entering into advice given the patient as to the treatment leading toward a satisfactory future state of health. Cholecystography is a most valuable aid in diagnosis. In the border-line cases of mild chronic cholecystitis, the surgeon is greatly aided in his decision to remove the gall-bladder by the recommendation of the clinician and röntgenologist.

In properly selected cases the abdomen can safely be closed without drainage after cholecystectomy.

END RESULTS IN CHOLECYSTECTOMY

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INFLAMMATION OF MECKEL'S DIVERTICULUM

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Acute inflammation of Meckel's diverticulum has especially interested the writers, since in a comparatively short time, July, 1927, to April, 1929, they have operated upon six cases. Four of these were reported in a previous paper.[1] The relative frequency with which we have observed this bizarre abdominal condition has so impressed certain diagnostic features upon us that we were able, in two of our last three cases, to anticipate, pre-operatively, the findings of an involved Meckel's diverticulum.

Case V.—A well-nourished female child, aged two and one-half years, was admitted to the United Israel-Zion Hospital October 27, 1928. The day before admission the child had developed abdominal cramps. An enema was given with some apparent relief. During the afternoon of the same day, the child vomited frequently. After taking some orange-juice, the abdominal pain became more marked. On the morning before the child's admission a bicarbonate of soda enema was given and a bloody return noticed. Abdominal pain was still present and very colicky. No fluids could be retained. The child appeared drowsy except when aroused by attacks of pain. Several spontaneous bloody discharges from the rectum appeared, especially after the attacks of colic.

Physical Examination.—On palpation of the abdomen, there was noted a sense of resistance in the upper right quadrant, but no mass could be definitely felt. The rectal examination was negative, but when the examining finger was withdrawn, there followed a gush of dirty, reddish-brown, bloody mucoid fluid. A barium enema given during a fluoroscopic examination showed that the clysma column had only passed to the hepatic flexure of the colon. Temperature was 100°F., pulse 100 and respiration 20. The total white blood cell count was 7,400, with normal polymorphonucleosis. The pre-operative diagnosis was intussusception.

Operation.—Through a right rectus incision, there was found a telescoping mass, at the hepatic flexure of the colon, which, when gently reduced, proved to be the cæcum telescoped into the ascending colon, ileum telescoped into the cæcum and part of the ileum telescoped within itself. About fifteen inches from the cæcum there was a free Meckel's diverticulum about one inch long, funnel-shaped, with a broad base, very hard at the distal end, and without a mesentery. Since the diverticulum was not acutely inflamed, it was considered a safer procedure to do a diverticulectomy at a later stage. This was done on December 27, 1928, when the child was readmitted to the hospital. At this time a subumbilical incision was made. The diverticulum was found as described. Diverticulectomy was performed by crushing the base of the structure with a clamp and removal by cautery, inversion of the stump and peritonealization. The recovery was uneventful. The examination by the pathologist confirmed the diagnosis of Meckel's diverticulum with intestinal mucosa.

Case VI.—A well-nourished boy, aged thirteen years, was admitted to the United Israel-Zion Hospital April 10, 1929. He had severe abdominal cramps the day before admission. The pain was localized at the umbilical region and was cramp-like in character. He had vomited about ten times since the onset of his illness; the temperature was 103°F., pulse 128 and respiration 28. The boy appeared extremely ill, with intensely flushed cheeks simulating pneumonia. The general toxic aspect was far more severe than that seen in the usual attack of acute appendicitis with associated peri-

tonitis. The thighs were drawn up. There was considerable abdominal distention. Tenderness and rigidity were most marked below the umbilicus and slightly to the right. Total number of white blood cells was 19,400, with polymorphonuclear leucocytes 86 per cent, and lymphocytes 14 per cent. The pre-operative diagnosis was acute inflammation of a Meckel's diverticulum.

Operation.—Right rectus incision. Upon entering the peritoneal cavity, there was an escape of a considerable amount of thin, free, cloudy, blood-tinged reactionary fluid. This was removed by suction. A Meckel's diverticulum was located adherent to the peritoneal surface of the umbilicus by a thin, tight, cord-like, ensnaring band, producing
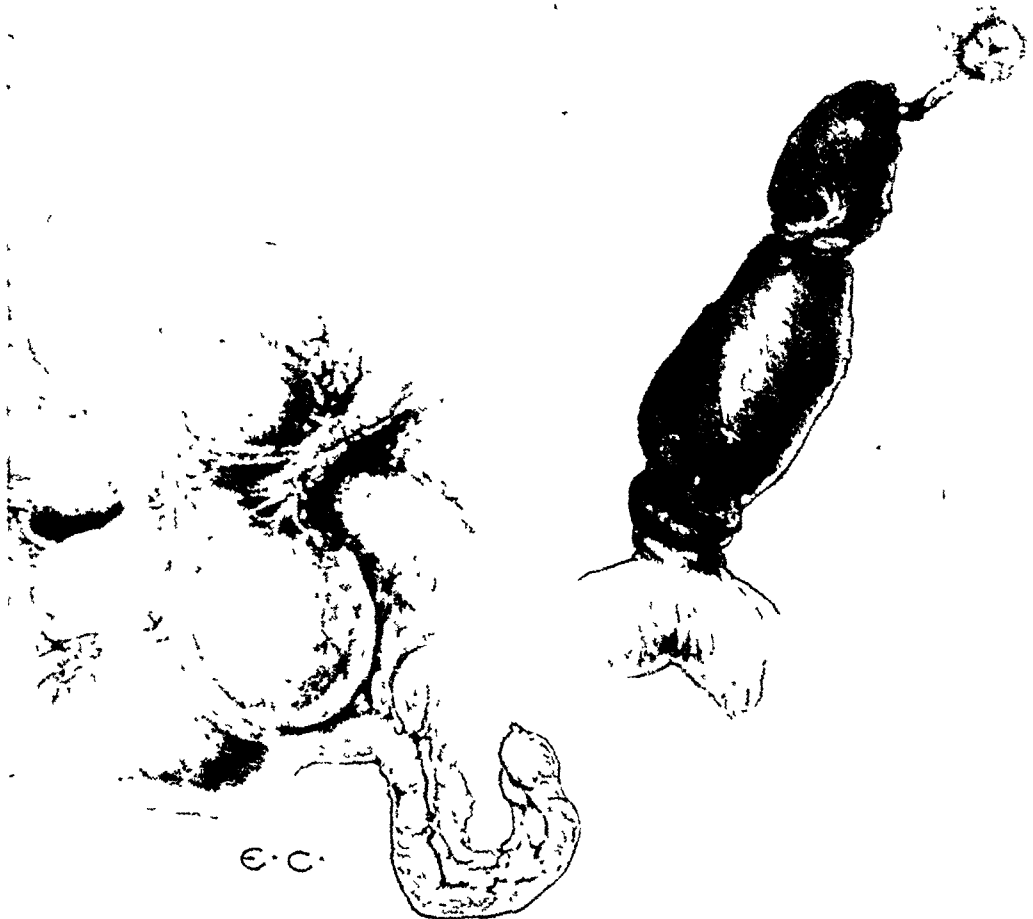
Fig. 1.—Blood filled Meckel's Diverticulum with torsion.

a torsion of the diverticulum. (Fig. 1.) It was found to be about sixteen inches from the ileocæcal junction, about five inches in length, purplish-black, and filled with blood. It had no mesentery. The lumen was approximately that of the parent ileum. The terminal end was blind, blunt and sausage-like, and the base sprang from the ileum opposite its mesenteric attachment. Diverticulectomy was performed with stump inversion and peritonealization. The appendix was removed. Recovery was uneventful.

Pathological Report.—Acute phlegmonous inflammation of Meckel's diverticulum.

Usually Meckel's diverticulum is an anomalous glove-finger-like sacculation or out-pouching of the ileum, and may be situated anywhere from several inches to three feet above the ileocæcal valve.[2] Almost any variation of size, shape and position may be possible.

This surgical condition was first observed by Lavater in 1671, and then by Ruysch in 1698. It was not until 1813, however, that John Friedrich Meckel first accurately and completely described this structure which carries his name.

Meckel's diverticulum, in contradistinction to all other forms of intestinal diverticula, is almost always a congenital entity. "In the beginning of fetal life the midgut is connected to the yolk sac by a wide canal called the vitelline duct. This duct is accompanied by an artery and two veins which maintain the circulation between the yolk sac and the intestines. At about the eighth week the duct becomes functionless, and, under normal conditions, disappears; the atrophy beginning at the distal end. In about two per cent., atrophy is not complete and varying portions of the duct remain, and it is this remnant of fetal life which is known as Meckel's diverticulum." [3]

The duct may remain patulous throughout its entirety, and thus form a fistulous communication from the small intestine to the umbilicus, discharging mucus and intestinal contents. More frequently the distal end of the duct may become obliterated, leaving only a fibrous cord which may become attached to the umbilicus, to the anterior abdominal wall or to any other structure in the abdomen. This cord or tip of the diverticulum may become attached to, and part of, an inguinal hernia (Littre), or to any portion of the mesentery (its most frequent attachment), or to a neighboring loop of gut (small or large), bladder, or appendix.

Meckel's diverticula vary greatly in size, from a slight nipple-like structure to one thirty-three and one-half inches long.[4] The duct is usually free of mesentery, although in two of our cases we found a distinct mesentery. The structure of its walls is similar to the ileum from which it springs, and its mucosal lining may contain Lieberkühn's glands and Peyer's patches. However, there are reported instances where the distal mucosa of the diverticulum revealed the gastric type of glands, whereas the proximal mucosa contained alkaline secreting glands. At the junction of these two types of glandular mucosa, ulcers may form.[5] These ulcers are homologous to gastrojejunal ulcers subsequent to gastrojejunostomy. The origin of this gastric type of mucosa has not been satisfactorily explained. The lumen of the diverticulum is in most instances the same size as the parent ileum, but at times the communication between the duct and gut is very narrow, with a valve-like action, or it may be entirely closed. In the latter case, the secreting glands of the mucous lining may give rise to the formation of cysts.[6]

Meckel's diverticulum is usually attached to the ileum opposite to the mesentery, but it may be at right angles to the latter or within the folds of the mesentery. In shape, the structure may be tubular, club-shaped, nipple-like, round or irregular.

Incidence.—All writers seem to agree that Meckel's diverticulum is present in from one to two per cent. in all human beings, but the actual figures of various investigators show a smaller percentage. It is present in males three

times as often as in females.[7] In our series there were five males and one female, and the average age was twelve years.

Christopher[8] summarizes Doefner's and Telling's statistics as follows:

DOEFNER'S FIGURES

Zurich .... 11,822 autopsies, 14 Meckel's diverticula
French & English ....4,848 autopsies, 90 Meckel's diverticula

Total ....6,670 autopsies, 104 Meckel's diverticula
1.5 per cent. ....

TELLING'S FIGURES

Dresden City .... 8,133 autopsies, 8 Meckel's diverticula
Boston City .... 1,382 autopsies, 11 Meckel's diverticula
Johns Hopkins .... 2,600 autopsies, 15 Meckel's diverticula
Bender Hygienic .... 953 autopsies, 5 Meckel's diverticula

Total ....13,068 autopsies, 39 Meckel's diverticula .3 per cent.

Balfour in a total of 19,600 consecutive laparotomies noted only fifteen Meckel's diverticula, a percentage of .14.[9]

McGlannan[10] found only three cases in more than 14,000 abdominal operations, and he adds that Coley and Fortune reported only fifteen Meckel's diverticula in 18,000 autopsies.

The surgical phenomena that may arise from the presence of a Meckel's diverticula are: 1. Intestinal obstruction. 2. Ulceration (with or without bleeding from rectum). 3. Intussusception. 4. Diverticulitis (acute or chronic).

Intestinal obstruction is by far the most frequent surgical complication of a Meckel's diverticulum. This may occur in a variety of ways; Halstead classifies them as follows:

A. *Free unattached diverticulum.*—(1) Knot tied around gut. (2) Dragging and kinking of a loop of intestine by a distended or cystic diverticulum. (3) Twisting of the bowel at the point of origin of the diverticulum. (4) Chronic inflammation of Meckel's diverticulum and intestine with cicatricial narrowing. (5) Acute diverticulitis.

B. *Diverticulum attached to the abdominal wall or an abdominal viscus.*—(1) Band constricting or interfering with the blood supply. (2) Volvulus produced by a loop of gut passing between the diverticulum and becoming twisted. (3) Volvulus of a loop of intestine attached to the diverticulum with the diverticulum as a fixed point of rotation. (4) Strangulation over a tightly drawn diverticulum. (5) Acute diverticulitis. (6) Prolapse of intestine through umbilical fistula.

Ulceration is the most frequent complication of Meckel's diverticulum. The ulceration is analogous to that occurring in the stomach, and may be referred to as a peptic ulcer of a Meckel's diverticulum. Often the clinical picture is that of a pale child with a story of repeated intestinal hæmorrhages of bright red blood unmixed with mucus. These hæmorrhages may be so

profuse as to cause a marked anæmia.[11] Vomiting and epigastric pain may be present.

Hæmorrhages may be followed by perforation; the condition is then much more serious than perforation from a gastric ulcer, because the contents of the ileum are more infective. In a series of thirteen collected cases (all in boys), two of which were operated by them, Stulz and Woringer[12] reported ten perforations with seven deaths.

Intussusception is not infrequently caused by a Meckel's diverticulum invaginating itself into the ileum.[13] Here the severe pain, colic and vomiting are much more the prominent symptoms, whereas they may be absent in a bleeding diverticulum. The bleeding in an intussusception is usually not profuse and contains mucus.

Acute Diverticulitis (Meckel's).—Under this heading may be classified five of our six cases. While there is no distinct symptom or syndrome sharply differentiating this condition, there are certain peculiar characteristics that are helpful to make possible a pre-operative diagnosis of an acute inflammation of a Meckel's diverticulum.

The onset of this condition is usually abrupt. The pain is colicky and severe, appearing early and recurring. A very important feature is that the pain, tenderness and rigidity at the onset are usually localized near the umbilicus, about one-half inch below, either to the right or left. *Clinically the course simulates an acute inflammatory or perforative lesion of a hollow abdominal viscus, plus an early and partial intestinal obstruction.* If allowed to proceed without interference, a generalized peritonitis, perforation or obstruction may obscure the diagnosis completely. Vomiting is a constant and persistent symptom and tends to recur many times during the progress of the inflammatory process, due to the frequent attachment of the appendage to nearby organs; the ensnaring and kinking of intestines causes the frequent obstructive phenomena. Distention is a prominent sign and is evident rather promptly, in marked distinction to an early case of appendicitis. This distention is usually most distinct below the umbilicus. The temperature is often high, frequently 103° F. The patient appears acutely ill and the toxic reactions are more marked than in appendicitis.

Treatment.—No case of Meckel's diverticulitis can be considered innocuous; the likelihood of frequent and serious complications are many. Diverticulectomy with stump inversion and peritonealization is required. Care must be taken that the lumen of the gut is not narrowed. If perforation and a diffusing peritonitis have occurred, due to delayed operation, the treatment then is directed to both conditions. If ileus has resulted, drainage of the ileum above the lesion by an enterostomy is indicated. In none of our cases was this measure necessary.

SUMMARY

Six cases (the last two reported here), five males with acute inflammation of Meckel's diverticulum, and one female with a Meckel's diverticulum

not acutely inflamed, were operated upon within a period of two years—all recovered.

Pre-operative diagnosis, in two of our last three cases, was based on the persistent and repeated colicky pains, the localization of the maximum point of tenderness near the umbilicus, the recurrent vomiting, the severe toxicity, distention and high temperature.

In all acute surgical abdominal conditions, when the findings at operation are not sufficient to account for the symptoms, a search should be made for a Meckel's diverticulum.

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THE SURGICAL TREATMENT OF URINARY INCONTINENCE IN WOMEN *

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IMPAIRMENT of bladder control is a frequent cause of complaint among women seeking relief from the disabilities consequent on childbearing. I have looked over the follow-up records filed under cystocele and prolapse at St. Luke's Hospital in an effort to determine the frequency with which incontinence was present as well as the result of treatment. These cards record only the chief complaints of the history so that information gleaned from them gives merely the proportion in whom vesical weakness was important in the patient's mind.

Seven of fifty-nine cases of cystocele and four of 175 cases of prolapse complained of some degree of incontinence. Combined, the incidence of deficient vesical control is 5 per cent. Of the eleven cases with incontinence there were follow-up reports in ten. All but two of these were described as having a good result or being improved. These figures indicate that in general the operations done restored the bladder control. Taylor and Watt [1] found the incidence of loss of control in a series of hospital cases to be 2 per cent.

There are, however, a few patients in whom incontinence is complete or almost so, presumably associated with injury to the sphincter, who present a difficult problem to the surgeon. The following report describes such a case.

Mrs. E. D., a matron, forty years of age, was admitted to St. Luke's Hospital February 22, 1928, complaining of falling of the womb and inability to hold urine. Since her first confinement twenty-two years before she had had some degree of prolapse. Subsequent to the birth of the fifth and last child six years before she had not been able to prevent leakage of urine while on her feet. When sitting or lying down she remained dry.

On examination she was a healthy appearing, rather obese woman. There was a marked cystocele and moderate rectocele. The cervix was hypertrophied. The fundus remained anterior and apparently well supported.

Trachelorrhaphy, anterior colporrhaphy and perineorrhaphy were done for her relief. The anterior colporrhaphy was of the side-to-side overlap type. Convalescence was uneventful.

Three months later she was readmitted to the hospital because of continued incontinence, worse than before the operation. She could not walk without drenching herself. Examination revealed what appeared to be an excellent anatomical result from the previous plastic operation. Pressure on the abdomen or anterior vaginal wall, however, caused a flow of urine to come from the urethra. A cystoscopic examination was negative except for relaxed sphincter. A Kelly operation was done. With a catheter in

the bladder as a guide an incision was made in the anterior vaginal wall down to the base of the bladder. The vesical neck was plicated and the urethra narrowed by buried sutures, redundant vaginal mucosa was excised and the incision closed. The urethra at the close of the operation grasped a metal catheter tightly.

Following this operation the patient could not void and was unfortunately allowed to accumulate forty ounces in the bladder before being catheterized. It was necessary to depend on catheterization for four days. On discharge on the ninth day it was noted that the patient was continent.

For about two weeks following discharge she was well, but thereafter the incontinence returned and became worse than ever before. She was unable to go among friends because of the continued wetness and urinous odor and had to give up a job at a summer camp. Even in bed she did not remain dry and wore a pad. At a second cystoscopic examination six months after the second operation the sphincter was described as congested and relaxed with the edge running directly even with the bladder wall. The trigone and remainder of the bladder were normal. A diagnosis of relaxed sphincter was again made.

The patient's deplorable condition, worse since her previous operations, demanded relief, yet to the perplexed surgeon the current textbooks had little to offer other than the Kelly procedure, while the complicated muscle plastics reported from time to time seemed hardly indicated before simpler procedures were given a further trial. In view of the experience of the last operation at which time the sutures were undoubtedly put to undue strain, and under the stimulus of an article on female epispadias by Davis[2] in which he emphasized the importance of suprapubic drainage with sphincter repair, it was determined to employ this principle.

The patient entered hospital for her third operation in January, 1929, eleven months after the first and seven after the second intervention.

A suprapubic cystotomy was done first. The patient was then put in the lithotomy position and with the finger of an assistant in the urethral orifice of the bladder as a guide the base of the bladder was exposed through an incision in the anterior vaginal wall. The mucous membrane of the bladder was accidentally torn through in making the dissection but it was repaired at once and no harm resulted. Although it was not possible to identify sphincter muscle as such the musculature at the neck of the bladder was recognized and tightened by sutures. In order to include every step that might help in the cure an interposition was added. The bladder was drained suprapubicly.

Convalescence was uneventful. The patient was allowed out of bed on the fourteenth day with the tube clamped. She voided on the fifteenth day. On the seventeenth day the tube was removed. On discharge from the hospital on the thirty-third day the wound was completely closed and the patient continent.

She has remained cured to date, more than one year, and has been able to resume all her activities. She can cough or laugh without losing a drop of urine. She voids three or four times by day and gets up once at night. On examination the bladder is well held up by the interposition.

Anatomy.—Descriptions of the vesical sphincter vary sufficiently to confuse the reader as to details. In general it may be said that there is an internal sphincter of smooth muscle, and an external, consisting of the voluntary muscles surrounding the urethra, the compressor urethra and bulbocavernosus, which supplement the action of the more important internal sphincter.

According to McCrea[3] the internal sphincter consists of two parts which together form an encircling band at the vesical neck, an inner, continuous with the muscle fibres of the trigone, the sphincter trigonalis of Kalischer; and an outer, derived from the posterior band of the external longitudinal

muscular coat of the bladder. The circular muscular fibres of the bladder which have been considered by some writers as the origin of the sphincter musculature form an incomplete ring just above the sphincter, deficient posteriorly. The internal sphincter is therefore intimately connected with the trigone and base of the bladder and represents a combination of their fibres looping around the vesical neck and upper end of the urethra. The result of this arrangement is that at operation the vesical sphincter is not to be separately identified as in the case of the anal sphincter, at least in my experience and I would judge that of others, and sutures designed to repair it must include in general the musculature of the bladder neck and adjacent portion of the urethra.

Pathology.—Relaxation of the sphincter is a term often used in discussing the incontinence of women who have born children and expresses undoubtedly a common conception of the underlying condition. The fact, however, that some degree of incontinence is not rare in women with cystocele and that it is usually cured by operative repair of the cystocele demonstrates that an injury of the fibro-muscular supports of the bladder and urethra is an important cause of impaired vesical control. Taylor and Watt,[1] Watson,[4] Bonney,[5] Miller,[6] and Latzko and Schiffman [7] emphasize this as the principal feature. Miller [6] believes that where prolapse is incomplete, the base of the bladder descending while the urethra is held up, incontinence is more likely than in complete prolapse, because in the former the sphincter is held open. The greater incidence of incontinence among the St. Luke's cases of cystocele as compared with those of more extensive prolapse would seem to support this view.

Stoeckel,[8] who has had a large experience in the treatment of incontinence, emphasizes the importance of lacerations of the internal sphincter itself and restricting adhesions to it.

A third theoretical cause would be injury of the innervation of the sphincters. As that of the internal sphincter is through the pelvic plexuses which follow the arterial branches it would seem unlikely to be of importance and in fact I have found no evidence in looking over the literature that it is so. A possible injury of the internal pudics which supply the muscles forming the so-called external sphincter seems of even less practical import.

It may be concluded that impairment of the bladder and urethral supports is the common cause of incontinence in parous women but that on the other hand injury to the internal sphincter itself must be present in the more severe cases.

In the patient described above the condition grew worse after an anterior colporrhaphy and perineorrhaphy the result of which was considered anatomically good, so that sphincter injury remained as the explanation. This was furthermore borne out by cystoscopic examinations which showed the sphincter to be relaxed.

Treatment.—Where a careful repair of the anterior vaginal wall and other prolapse is insufficient to cure the incontinence, the Kelly operation, a

reefing of the tissues at the bladder neck, thereby restoring the sphincter mechanically, is the operation generally practised. Kelly and Dumm,[9] reported sixteen of twenty cases cured by this procedure. Furness,[10, 11] reports 80 per cent. of successes. In some instances where a vaginal operation was not feasible he has tightened the sphincter through a suprapubic approach. E. L. Young, Jr.,[12] has reported a series of eighteen cases with no known failures. He emphasizes the plication of the vesical sphincter, and second, a careful repair of the fibro-muscular tissues forming the external sphincter.

Other operations frequently mentioned are the Gersuney, which depends on a twisting of the urethra, the Dudley, a forward displacement of the urethra which tightens and angulates it, and paraffin injections whose purpose is to narrow the calibre of the urethra. These are all based on wrong principles in my opinion and are mainly of historical interest.

The Germans, judging from their literature, have taken the most interest of recent years in the problem under consideration. Stoeckel,[8] considers the direct plastic on the sphincter muscle as the basic method of attack. For such cases as are not cured by this procedure he describes three operations, pyramidalis plastic with which his name is associated, levator plastic and interposition.

The pyramidalis plastic introduced by Goebel and first used by Stoeckel in a case of acquired incontinence consists in bringing two muscular strips, theoretically consisting of the pyramidalis muscles, but which may for practical purposes include rectus or fascia, down back of the symphysis and suturing them together underneath the vesical neck. Their bases are left attached above. According to Latzko and Schiffmann,[7] more than 100 of these operations have been reported with very good results. The levator plastic of Franz consists in suturing strips from the upper part of the levators to each other underneath the vesical neck. Their bases are left attached to the pubic bone. Both the pyramidalis and levator plastic depend on supporting rather than sphincter action.

Other muscle plastics using the musculature of the thigh or even the gluteus have been recorded according to Latzko and Schiffmann. Mention should be made of the gracilis plastic devised and carried out by Deming,[13] of New Haven, who achieved a brilliant success in a young woman with epispadias, incontinent since birth.

Finally it has been observed that the interposition operation has been helpful in cases of incontinence, supporting as it does the base of the bladder.

Discussion.—To return to the direct plastic on the vesical sphincter region, as already mentioned, the percentage of successes by this simple procedure is considerable yet the outcome is uncertain. Kelly and Dumm in their series found that of three patients whose incontinence was complete none was cured. In the writer's patient it could be demonstrated by the catheter at the time the Kelly operation was done that the vesical neck was tightened yet it was manifest very shortly after she left the hospital that the repair had given away.

Obviously the important principle of rest to the part is not applied when the healing vesical neck is expected to continue to function. If this indication is met by an indwelling catheter or repeated catheterizations the distention of the repaired orifice seems equally hazardous to a satisfactory outcome.

The value of functional rest in intestinal surgery is well understood and practised and needs no detailed discussion here.

Davis,[2] reporting a successful case of female epispadias, says: "It is remarkable that in not one of the cases operated upon up to 1923 is there any mention of a diversion of the urine by means of a drainage tube in the bladder. In some cases the patients were left to pass their urine over the freshly sutured field of operation and in others a retention catheter was left in place for a certain length of time. This seems remarkable inasmuch as other surgeons who had been operating on urethral defects in the male, particularly hypospadias, had long before this discovered that diversion of the urine is absolutely necessary in order to secure healing in a sufficiently large proportion of cases. Young first put this principle into effect in 1923."

H. H. Young[14] described cures in cases of incontinence following perineal prostatectomy as well as in a case of epispadias by an internal sphincter repair through the bladder, and external sphincter repair through the perineum, combined with bladder drainage.

Lowsley,[15] in an article on incontinence, reported a woman with relaxed sphincter following childbirth in whom he repaired the sphincter through the bladder with bladder drainage as in Young's operation for epispadias. She had in addition a small vesico-vaginal fistula requiring closure.

On searching the literature since the appearance of Kelly's operation on relaxation of the vesical sphincter in women there is almost no mention of extraurethral bladder drainage. Stoeckel[8] is a notable exception. In his textbook he states that in all cases where the urethra or bladder neck is operated upon bladder drainage, preferably infrasymphyseal, by a catheter introduced through a trocar, should be practised as an intraurethral catheter must press on the sphincter sutures and disturb healing mechanically.

Mikulicz-Radecki,[16] of Stoeckel's clinic, has used this principle in part of his cases. Lowsley's case has already been cited.

To my mind suprapubic drainage seems preferable to infrasymphyseal because it aids in the dissection and closure of the vesical neck to have a guiding finger in the bladder. One reason I think for hesitancy in the use of suprapubic bladder approach and drainage is that it seems to add a considerable procedure to an operation often successful without it. As to the hazard, I believe it is little increased, although convalescence will be somewhat longer than after plastic procedures alone, a small price to pay for a successful outcome.

It is manifestly unwise to urge an operative plan on the basis of one case. Furthermore in this patient reported it must be conceded that a second attempt at a Kelly repair without drainage of the bladder might well have been successful, particularly with the addition of the interposition. On the

other hand the principle of securing rest by temporary diversion of the urinary flow is of unquestioned value and in the writer's opinion its application in this case was an important factor in the satisfactory outcome.

CONCLUSION

A careful plastic repair of the anterior vaginal wall with such other gynecological procedures as may be indicated will correct the impaired bladder control of which many of these sufferers complain in the majority of instances. When the incontinence is more pronounced the Kelly operation of tightening the vesical sphincter combined with colporrhaphy gives a cure in a considerable proportion of women with relaxed vesical sphincter. Where this procedure failed in a case of severe incontinence the addition of bladder drainage to the plastic on the sphincteric region supplemented by an interposition gave an excellent result. In view of the apparent neglect of the principle of temporary diversion of the urine in the repair of relaxed vesical sphincter in parous women this report is offered with the hope that it may be of use in similar situations and perhaps obviate the necessity of employing more complicated procedures.

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THE SURGICAL TREATMENT OF GENITAL ELEPHANTIASIS IN THE MALE

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Filarial elephantiasis is rare in the continental United States, but cases of lymph scrotum and penis appear occasionally, due usually to lymph block following extensive inguinal inflammation. Practically all of the cases seem to be complicated by a low-grade streptococcus infection in the œdematous tissues, which may give rise to acute inflammatory reactions of greater or less severity and at varying intervals. The victims of this condition are greatly troubled by it, and all wish for relief. Surgeons in tropical countries have, as a result of extensive experience, formulated the conditions of surgical treatment and their conclusions are equally applicable to the cases occurring here.

The fundamental principle is that of complete removal of all affected tissues. This usually means the entire area drained exclusively by the inguino-femoral lymph-nodes; namely, the scrotum and penis, and sometimes limited zones in the presymphyseal and anterior perineal areas. The glans penis and inner leaf of the prepuce are usually unaffected, since their lymphatics anastomose with those of the urethra, and in the same manner the testes, epididymes, and spermatic cord usually escape, having their own drainage into the pre-aortic nodes. Some degree of hydrocele is, however, not infrequently present.

There is an intense œdema of the subcutaneous tissues giving an appearance of transparent, gelatinous masses. The overlying skin becomes thick, rough and brawny, and is often dusky or purplish in color. The streptococcus infection may cause the skin to be intensely red and inflamed, even weeping. The weight of the enlarged scrotum may drag normal areas of skin from either side of the perineum, or even from the thighs, down so that it forms part of the lateral aspects of the upper part of the scrotum. This skin, if present, and the inner layer of the prepuce, may be used to help cover the defect left after operation. All other skin and subcutaneous tissue showing even the slightest sign of involvement must be ruthlessly cut away. The only organs to be carefully spared are the urethra and corpora cavernosa, the testes and their appendages, the spermatic cords, and the dorsal vessels of the penis. The tunica vaginalis should be split and turned back over the spermatic cord ("bottle operation") to avoid the possibility of a subsequent hydrocele. It is surprising how well the penis and testes can usually be covered by drawing up the adjacent normal skin, but if this is impossible, the testes are simply to be tacked to the perineum. They and the penis can then later be covered by skin grafts.

The vascular supply to the enlarged organs is usually much increased.

Bleeding has caused many surgeons to recommend doing the operation with the aid of a tourniquet passed around the base of the scrotum. It is, however, quite simple to clamp and cut the vessels as one proceeds, and the tourniquet may be much in the way.

Very great enlargements of the scrotum may surround and enclose the penis, until one can see nothing of it but a deep dimple on the anterior surface of the scrotum. In such cases the dimple must be split up to find the penis.

Sir Havelock Charles,* of Calcutta, advises an operation almost exactly as described above. He uses no tourniquet, makes his incision in healthy skin, regardless of where it may lead him, and undermines the skin of each side of the perineum to allow it better to be drawn over the defect. He uses skin grafts if necessary.

H. W. L. Waller† substitutes for the tourniquet a clamp made of two straight pieces, one lying in front of the scrotum, the other behind. These pieces are drawn together by screws passing one on each side of the scrotum. He makes a horseshoe incision on the anterior surface of the mass, its limbs parallel and directed upward, and joined below the penile dimple. This gives a horseshoe flap which he uses to cover the penis. One would think that in many cases the skin in this region would be œdematous and unfit for such a purpose.

Sir Douglas Manson‡ uses a tourniquet arranged as in the accompanying diagram (Fig. 1). This arrangement exerts lateral pressure on the scrotum and allows the tourniquet to be placed higher than if it simply encircles the base of that organ. He insists upon the importance of removing all diseased tissue, cutting in healthy skin, and paying no attention to the possibilities of repair until excision is complete, since if there is insufficient skin, skin grafting is easy and satisfactory.

Fig. 1.—Manson's method of applying tourniquet before operating upon scrotal elephantiasis.

Hugh H. Young in this country reported a case in his "Practice of Urology," in 1926. He used no tourniquet and removed the very large scrotum radically, but even so was able to cover the raw surfaces completely

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* Quoted by McCaw, Keen's Surgery, vol. iv, p. 1120, 1914.

† Lancet, vol. ii, pp. 1132-1133, 1923.

‡ Tropical Diseases, 8th edition, 1925.

and did not have to resort to grafting. The retracted inner layer of the prepuce covered practically the entire penis.

The two case reports following represent moderate-sized enlargements. The first was the larger, and an excellent result was obtained following operation. In the second, the œdema affected only the penis and the anterior two-fifths of the scrotum, but conservatism engendered by this limited involvement led to an incomplete procedure, and a second operation was necessary to complete the cure.

Case I.—W. G. W., aged forty-three, entered the Strong Memorial Hospital, Rochester, N. Y., September 28, 1927. The family history was negative. In the past history were pleurisy on the right sixteen years previously, and more recently a good deal of trouble with the right foot and ankle, consisting of arthritis and osteomyelitis following an injury. Twenty years previously there had been some genito-urinary disease. The patient stated that he remembered it only vaguely, but it appeared that there was some urethral discharge, followed by an abscess in the right inguinal region, which was opened and drained. There was no history of a genital sore. Two years before admission, itching and burning of the scrotal skin commenced, followed a week later by swelling. Rest in bed, catharsis, and cold applications reduced the swelling, but it returned on arising, and continued to increase slowly but steadily for two years, involving the penis as well. Examination showed extensive scarring in the right inguinal region, but, surprisingly enough, none on the left. The left inguinal nodes were somewhat enlarged. The scrotum measured sixteen centimetres long and thirty centimetres in circumference. The penis was about four centimetres in diameter. The skin over the scrotum was thickened and brawny, that over the penis almost normal. The Wassermann and Kahn tests were negative, the blood count and differential normal. The blood-pressure 105/80. Repeated examinations for filaria in the blood were negative.

Operation was performed October 25, 1927. In view of the comparatively slight involvement of the penis, it was decided not to operate upon it. Some normal skin on each side of the scrotum was saved. Posteriorly the incision passed four and one-half centimetres in front of the anus. The lateral flaps were undermined to remove all of the œdematous tissue, and at the end, the bulbous urethra was entirely exposed. A bottle operation was done on each testis. The lateral flaps allowed the defect to be completely covered. One small rubber tissue drain was placed at the posterior angle of the incision and closure was by skin clips. Streptococci were found in the tissue removed. The patient left the hospital sixteen days later. He was seen two months after discharge at which time the wound was entirely healed. The penile œdema was markedly decreased, and intercourse was satisfactory. The new scrotum looked the same as at the time of discharge from the hospital, that is, considerably smaller than normal. He considered himself cured.

Case II.—J. B., aged forty-two, admitted to the Brady Urological Institute, Johns Hopkins Hospital, March 20, 1929. The family history was negative. The past history was also negative, except for matters concerning the present illness. About 1909 there was an attack of gonorrhœa. About 1911 there was a penile sore, accompanied by bilateral suppurative inguinal bubo, both sides being incised and drained. In 1913, there was an attack with constipation, malaise, general lassitude, chill, fever, swelling of the anterior part of the scrotum and of the penis, reddening of the skin, and difficulty of voiding due to swelling. This attack lasted several days. Such attacks continued to occur about every six to twelve months, and the swelling remained between attacks and increased gradually. On several occasions the patient made incisions in the scrotum to relieve the tension. Examination was negative except for the genitalia. There were extensive scars in both groins. The penis was swollen, œdematous, dusky and cyanotic,

FIG. 2.—Case II. Photograph of genitalia before first operation. Note scars of self-inflicted incisions.
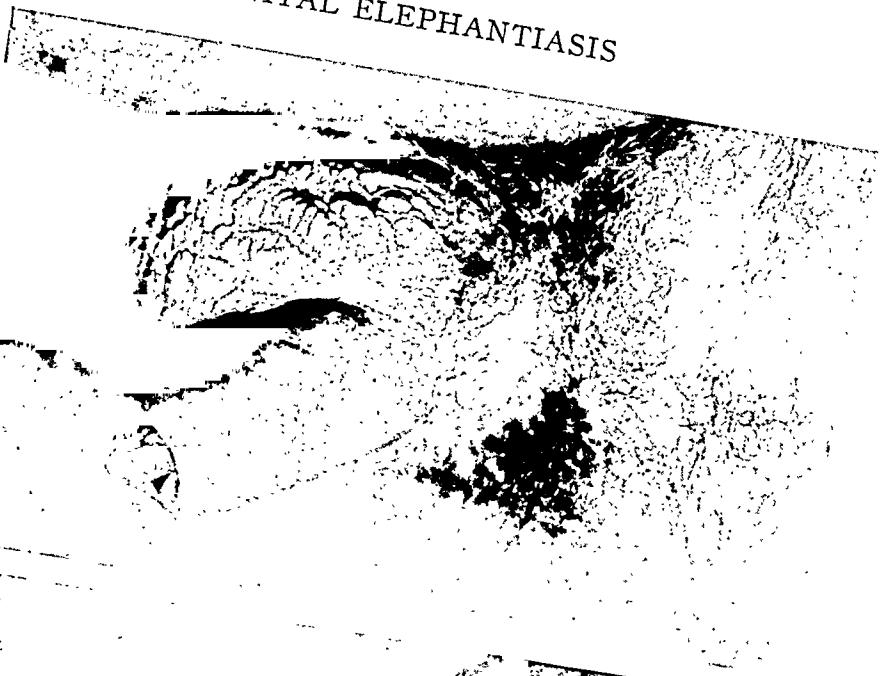
FIG. 3.—Case II. Photograph made shortly after first operation.
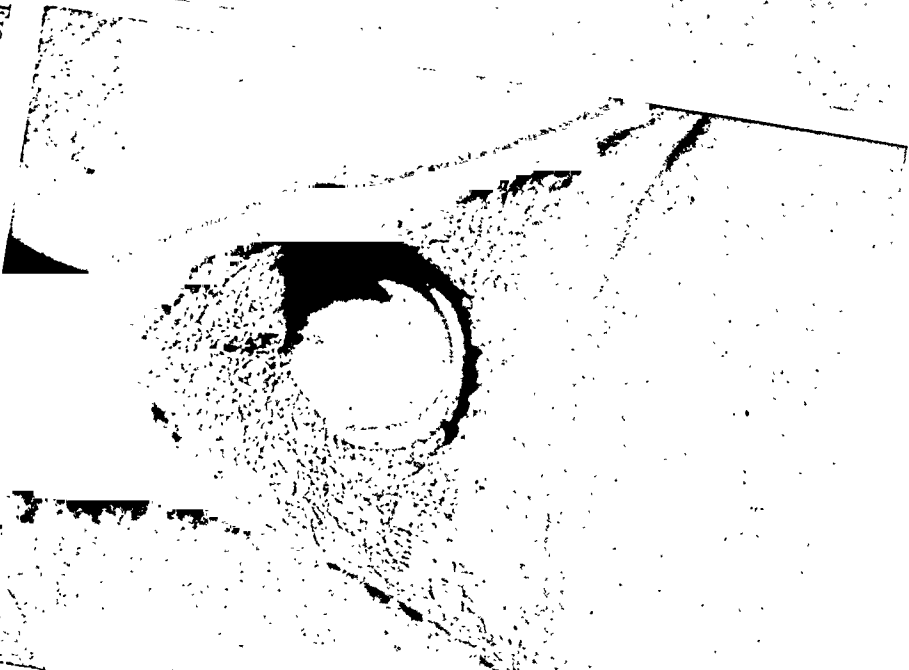
FIG. 4.—Case II. Photograph made seven months after second operation. Note normal scrotum, slight œdema of prepuce.

blanching on pressure. The skin was definitely thickened. The inner layer of the prepuce was normal. A similar change involved slightly less than the anterior half of the scrotum. In the upper part on the right were linear scars of the incisions the patient had made. The testes and epididymes were normal (Fig. 2).

Operation was performed March 22, 1928. A bottle operation was done on each testis. All œdematous tissue was removed from the scrotum and penis, and all the thickened skin except small areas of slightly involved skin on each side of the scrotum and at the base of the dorsum of the penis. It was hoped that collateral lymph circulation would take care of these, allowing a more perfect plastic repair. The inner layer of the prepuce served to cover the penis. The excision was done with the radio knife. One small drain was placed and closure was by plain catgut sutures subcutaneously drawing the halves of the scrotum together, with fine black silk to the skin. The specimen measured fourteen by four and one-half by six centimetres, and weighed 154 grams. The patient left the hospital in about two and one-half weeks (Fig. 3).

The result appeared to be good for a month, when another typical attack occurred, involving the areas of abnormal skin left behind at the operation at the base of the penis and on the left side of the scrotum.

A second operation was therefore performed August 30, 1929. The plan was similar to that employed at the first operation, except that it was more radical, the incision passing everywhere through normal skin and all tissue that was even suspicious being removed. The inner layer of the prepuce was still good and again served to cover the penis. In order to prevent it sliding forward, it was anchored dorsally to the periosteum of the symphysis pubis, and ventrally to the tunica albuginea of the bulb of the urethra, using fine chromic catgut. The halves of the scrotum were drawn together as before. The patient left the hospital eighteen days later.

The result was observed seven months later. The patient felt very well, and had had no further attacks. The scrotum looked almost normal. The penis was free, and appeared like a normal penis except for a little ring of soft œdema behind the coronary sulcus. The skin was not thickened. The photograph (Fig. 4) shows the organs at this time. It does not do justice to the penis which, when drawn up, was fully five centimetres long in the clear while flaccid.

The patient was again seen June 15, 1930. No further attacks. The preputial œdema has practically disappeared.

TORSION OF THE SPERMATIC CORD IN INFANCY

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THE infrequency with which torsion of the spermatic cord is found in infancy leads me to report the three following cases operated upon by me at The Babies Hospital in 1928. The only case previously reported from The Babies Hospital was operated upon by Doctor Farr in 1911. The three following cases were admitted within a period of ten weeks. In 1901 Scudder reported thirty-one cases, all there were in the literature at that time. Two of these were under one year of age. Since that time, 163 cases have been reported, thirteen of which were less than one year old.

Torsion may occur at any age, most of the cases reported having been in young adults of twenty years of age. The youngest case on record is an infant at birth, reported by Taylor in *The British Medical Journal* in 1897. This child was operated upon two days later and the testicle found gangrenous. The cases reported here were eight, eight and ten months of age. The condition seems to be much more frequent in incompletely descended testes and somewhat more common on the right side. Two of my cases were on the right side, the testis being found in the inguinal canal in each. In two of them an indirect inguinal hernia was found, neither sac communicating with the tunica vaginalis.

The exact cause of torsion is unknown, but nearly every author has reported some abnormality in the attachment of the testis to the cord and epididymus. The most common findings are a capacious tunica vaginalis and either a long or broad mesorchium. A brief review of the embryology shows that the testicle and epididymus develop as separate structures, retroperitoneally, at the lower pole of the kidney, each with a separate mesentery attaching it to the posterior abdominal wall. The mesorchium is the original mesentery of the testicle and ceases to exist when the two mesenteries fuse as they normally do at about the fourth month of intrauterine life. With an unobstructed passage the testis and epididymus reach the scrotum by the ninth month of foetal life. When there has been some interference with this fusion and passage to the scrotum, it is not uncommon to find a long mesorchium or a wide separation of testis and epididymus. Great variations in the attachment of the spermatic cord to the testis have been reported. These conditions, no doubt, predispose to torsion, and since abnormalities are more common in incompletely descended testes, it is probably for this reason that torsion is more often found where the testis has not reached the scrotum. In two of my cases, necrosis had reached a point that it was impossible to define the mesorchium, but each case showed a large tunica vaginalis.

It has been shown by experimental work that necrosis of the testis

develops if a complete torsion has existed for thirty hours. In my cases, the testes were found to be blue hæmorrhagic masses, the microscopic examination in each case showing advanced necrosis with almost complete loss of the structure of the testicle. The necrosis was less marked in the epididymus.

The most striking thing about these cases was the complete absence of symptoms in two of them. The other patient had been irritable with some vomiting and diarrhœa for three days. None of them looked sick; all were afebrile. All of them were brought to the hospital because the mothers had noticed a mass in the gorin while bathing the babies.

Perhaps the most important points in the diagnosis of torsion are the presence of the inguinal mass and the absence of the testicle from the scrotum on the corresponding side. There may be a change in the color of the skin over the mass, but this was absent in two cases. Fluid may be present in the tunica vaginalis, and, if bloody, may help in the diagnosis. In none of these cases was the tunica vaginalis explored with a needle before operation as I consider the procedure too dangerous, particularly if the mass happens to be a strangulated hernia instead of torsion of the cord. In all of these cases the opposite testis was of normal size and in the scrotum.

The three conditions with which torsion is most apt to be confused are (1) Acute epididymo-orchitis. This condition is so rare in infancy that it is much safer in the presence of the signs to consider the case one of torsion. (2) Strangulated hernia. It is often impossible to differentiate between these two conditions. Since both require immediate operation, there is little point in spending time in an effort to make an exact diagnosis. (3) Acute inguinal adenitis. There will usually be some reason for the adenitis: either an infection of the leg, foot, or anal region, and a change in color of the skin over the mass.

No fatal case has been reported in the literature to date. Atrophy is sure to follow a complete torsion that has been present more than thirty hours. Sloughing and infection have been reported but are the exception rather than the rule. Infection is much more serious if there is an accompanying hernia sac through which the infection may reach the peritoneal cavity.

In complete torsion, if the circulation in the testis does not improve after detorsion and the application of hot pads, the testis and cord should be removed as the danger of infection in this badly damaged testis makes the chance too great to leave it. In incomplete torsion, simply straightening the cord out may suffice. In the above cases, there was no doubt at the time of operation what the best procedure was since necrosis to a rather marked degree had taken place in each case.

CASE I.—R. B. T., age ten months, was admitted to The Babies Hospital August 22, 1928, with a history of a 'swelling in the right groin for two days. Family history entirely negative. Patient was born three weeks prematurely but had shown normal development to date. Mother had noticed a swelling in the right groin two days before while bathing the baby. She had not noticed before that the right testis was not in the scrotum. She stated that the baby had shown no signs of pain nor discomfort either before or since she discovered the swelling. No history of trauma nor infection of

foot, leg or anal region. Physical examination was entirely negative except for the local condition. There was a mass in the right inguinal region three and one-half by two and one-half centimetres, movable, not tender nor attached to the skin. No change in the color of the skin over it; no abdominal muscle spasm; no sign of infection of the neighboring parts. The right testicle was not in the scrotum, the left testis was of normal size in the scrotum. Rectal examination was negative. Urine, negative. Temperature 99; white blood cells 11,800; polynuclears 66; lymphocytes 34. *Diagnosis.—Torsion of the spermatic cord* or strangulated inguinal hernia of right side. Operation.— Right inguinal hernia incision exposed a gangrenous testicle in the inguinal canal with the cord twisted twice in a clockwise direction. Tunica vaginalis contained considerable bloody fluid and was about twice the normal size. Cord untwisted, but circulation failed to return so the cord and testis were removed after transfixing the cord at the internal ring. Microscopic examination (Fig. 1) showed complete destruction of the tubular structures in the testicle and to a lesser degree in the epididymus. Convalescence uneventful. Discharged on the eighth day with his wound healed by primary union. Follow-up: One and one-half years, general condition excellent; incision well healed: free from symptoms.

CASE II.—E. C., age eight months, was admitted to The Babies Hospital October 29, 1928. Complained of being irritable, having a swelling in the groin about four days. Child has been perfectly well to date and had had normal development. Four days previously the mother had first noticed a swelling in the right groin while bathing the baby. Child had done no vomiting and had apparently been in no pain during the four days. Physical examination was entirely negative except for the local condition. There was a mass in the right groin three by two centimetres,
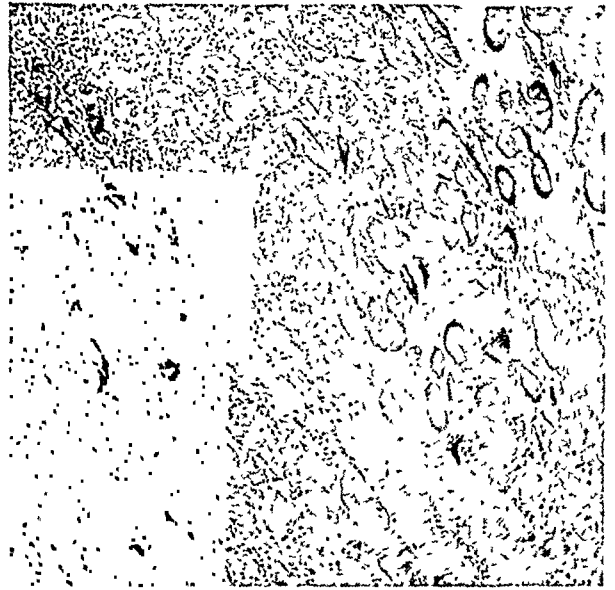
FIG. 1.—Microphotograph of testicle in Case I showing a large amount of hæmorrhage with almost complete destruction of the structure of the testicle.

firm, fixed and somewhat tender. Skin over it was not changed in color. The right testicle was absent from the scrotum, the left testicle was normal in size and position. There was no infection of the leg nor anal region. Temperature, 100; pulse, 80; respiration, 22. Urine, negative. *Diagnosis.—Torsion of the right spermatic cord.* Operated upon immediately, the testicle being exposed in the inguinal canal through the usual hernia incision. The testicle was about twice the normal size, blue, hæmorrhagic, with the spermatic cord twisted upon itself one and one-half times in a clockwise direction. There was an indirect inguinal hernia sac found when the cord was untwisted, and it was treated in the usual way. As the color failed to return to the testicle after the application of hot moist pads, it was removed with the cord. Convalescence uneventful. Discharged on the eleventh day with the wound completely healed by primary union. Microscopic examination of the specimen removed showed almost complete destruction of structure of the testicle with necrosis less marked in the epididymus. Follow-up: One year, five months, free from symptoms. Incision soundly healed.

CASE III.—F. P., age eight months. Admitted to The Babies Hospital November 3, 1928, complaining of swelling in the left groin, vomiting and diarrhœa for three days. Three days before while bathing the baby the mother had first noticed a swelling in the left groin. Baby had been perfectly well previous to this time, but had diarrhœa and

vomited about three times daily for the following three days. Physical examination: Well-developed, well-nourished, white male infant, eight months of age, irritable, crying and apparently in pain. General examination was entirely negative except for the following: there was a mass in the left inguinal region four by three by two centimetres, firm, fixed and quite tender. Skin over it slightly red. Left testicle absent from the scrotum. Right testicle of normal size in the scrotum. *Diagnosis.—Torsion of the incompletely descended testis.* Immediate operation, the usual left hernia incision exposing a mass consisting of the left testicle, cord and hernia sac twisted on the cord twice in a clockwise direction at the internal ring. Mass was hæmorrhagic, blue, rather densely adherent to the surrounding structures. (Fig. 2.) Upon release of the torsion and application of hot pads there was no change in the color of the testis. The hernia sac was treated in the usual way; the cord ligated at the internal ring and removed with the testicle. Incision closed with interrupted chromic. Convalescence was uneventful. Discharged on the seventh day with the wound soundly healed by primary union. Microscopic examination showed that there was complete loss of the structures of the testicle and epididymus. Follow-up: one year and five months later, incision well healed. Child entirely free from symptoms.

Fig. 2.—Photograph of the specimen in Case III immediately after operation, showing torsion of the cord just above the testicle and separation of the testicle and epididymus. The remnant of the accompanying hernia sac is seen at the upper part.

SUMMARY

1. Torsion of spermatic cord may occur at any age, but it is found most frequently in young adults.

2. It is most often found in incompletely descended testes.

3. Almost all cases show a long or broad mesorchium, a capacious tunica vaginalis or some abnormality in attachment of vas and epididymus to testis.

4. Atrophy of testis usually follows if torsion has been complete for thirty hours.

5. Sloughing and infection of testis may occur but not as frequently as atrophy.

6. Cases reported in infancy may lack the characteristic diagnostic signs found in adults.

7. Torsion must be differentiated from (1) acute epididymo-orchitis, (2) incarcerated inguinal hernia and (3) acute inguinal adenitis.

8. Orchidectomy should be done if circulation does not return after torsion has been corrected and heat applied.

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A DEPENDABLE METHOD FOR SUTURING STOMACH AND INTESTINES *

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AND

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An efficacious suture of the severed walls of stomach and intestine fulfills the following immediate, secondary, and ultimate requirements:

Immediate.—Accurate gas and fluid-tight approximation of serosa, subseroa, muscularis, submucosa, the mucosa is accomplished readily and gently with the use of the least amount of suture material compatible with safety; it is so accomplished that even partial obstruction of a viscus or stoma from puckering caused by continuous suture is avoided; only a narrow margin of the walls is included in the suture in order to restrict so far as possible interference with the neuromuscular mechanisms; an adequate blood supply of the margins is preserved to assure healing, yet so controlled as to prevent hæmorrhage into the lumen and intramural hæmorrhage. Moreover, the method should be applicable as a rule to lateral, end-to-side, and end-to-end anastomoses, to the closure of plastic and exploratory incisions.

Secondary.—Primary healing is provided and consequently an early restoration of function, particularly a reëstablishment of the normal gastro-intestinal gradient; an early disruption by peristalsis of entangling adhesions, *i.e.*, other than omental, that must form along the line of suture; and prevention of adhesions to parietal peritoneum.

Ultimate.—Minimal ultimate cicatrization at the line of closure to obviate subsequent marginal ulceration and stenosis of stoma.

In 1920, operations were performed by Thalhimer and Yates[1] upon animals in order to determine by macroscopic and microscopic examinations the accuracy of approximation of layers attainable by various sutures, the nature of the healing at subsequent intervals, and also the completeness of the reëstablishment of functions thereby provided.

Black silk was used as suture material because it could be readily recognized in gross examinations and identified in sections and would thus disclose the most favorable type of suture. It was found that however accurate the immediate approximation of the layers of intestinal wall appeared to be macroscopically, when examined microscopically it was, excepting the serosa,

surprisingly inaccurate. Nevertheless, the ultimate healing was quite as surprisingly good in that the layers had become reëstablished.

The following method was adopted because it fulfilled all of the immediate requirements save accurate layer-to-layer approximation which had been found to be unattainable but proved to be unnecessary and all of the secondary and ultimate requirements. Moreover, it fulfilled these requirements as well or better than other methods employed, some more complicated, none more dependable.

1. Approximation of serosæ posterior to the proposed stoma with interrupted silk mattress sutures; the two lateral sutures were beyond the angles of the stoma, left long
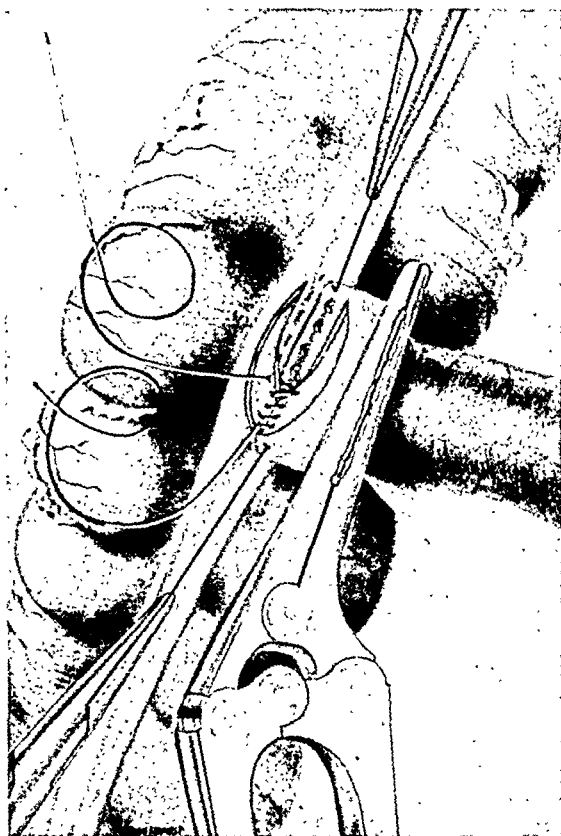
FIG. 1.—End-to-side anastomosis. Serosæ posterior to stoma united with interrupted silk mattress sutures. Lateral stitches left long, grasped in forceps, and counter traction applied to prevent puckering. Serosa, subserosa, and muscularis incised exposing submucosa, the incision not extending to lateral mattress sutures. Serosa, subserosa, and muscularis being approximated snugly with a continuous over-and-over catgut suture which includes the submucosa and provides hemostasis in structures external to submucosa.
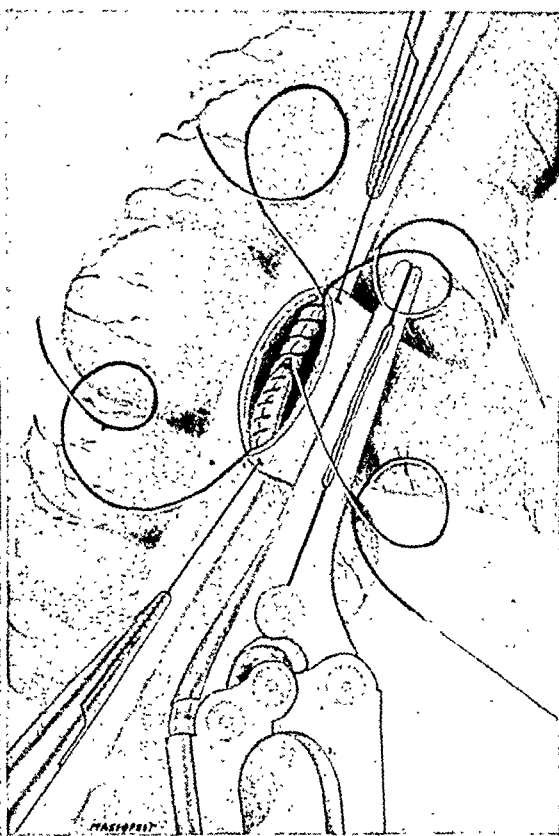
FIG. 2.—End-to-side anastomosis. Submucosa and mucosa have been divided close to preceding sutures (Fig. 1.) and open the lumens of the bowels. A continuous over-and-over suture is being inserted to unite posterior margins of mucosa and submucosa. Every third stitch includes the margins approximated by the sero-muscular suture and locked. Each stitch is drawn snugly to provide hemostasis in the layers internal to the submucosa.

and held taut so as to obviate contraction by the continuous sutures to be inserted and drawn snugly to prevent hæmorrhage. (Fig. 1.)

2. Incision of serous, subserous and muscular layers down to the submucosa one-half centimetre from and parallel to the row of interrupted sutures but not extended to the lateral sutures. (Fig. 1.)

3. A continuous over-and-over catgut (Dulox) suture is employed to approximate the posterior margins of the serous and muscular layers exposed by the incision. (Fig. 1.) The first stitch is inserted at one angle of the incision, tied, and its end left long to be tied again when the suture (Paragraph 8, Fig. 4) of the anterior margin is completed.

The stitches include the submucosa to give the backing needed to prevent their pulling out when drawn snugly and to compress the margins of the muscular and serous layers against the submucosa, thus providing for effective hemostasis in layers external to the submucosa and against the formation of dead space The last stitch is locked and is not cut

4. Incision of mucosa and submucosa close (0 5 centimetres) to the previous suture and, if necessary, aspiration of contents from the lumens of the viscera which are now opened.

5 A continuous over-and-over catgut (Dulox) suture approximates the posterior margins of the mucosa and submucosa The first stitch is inserted at the angle opposite
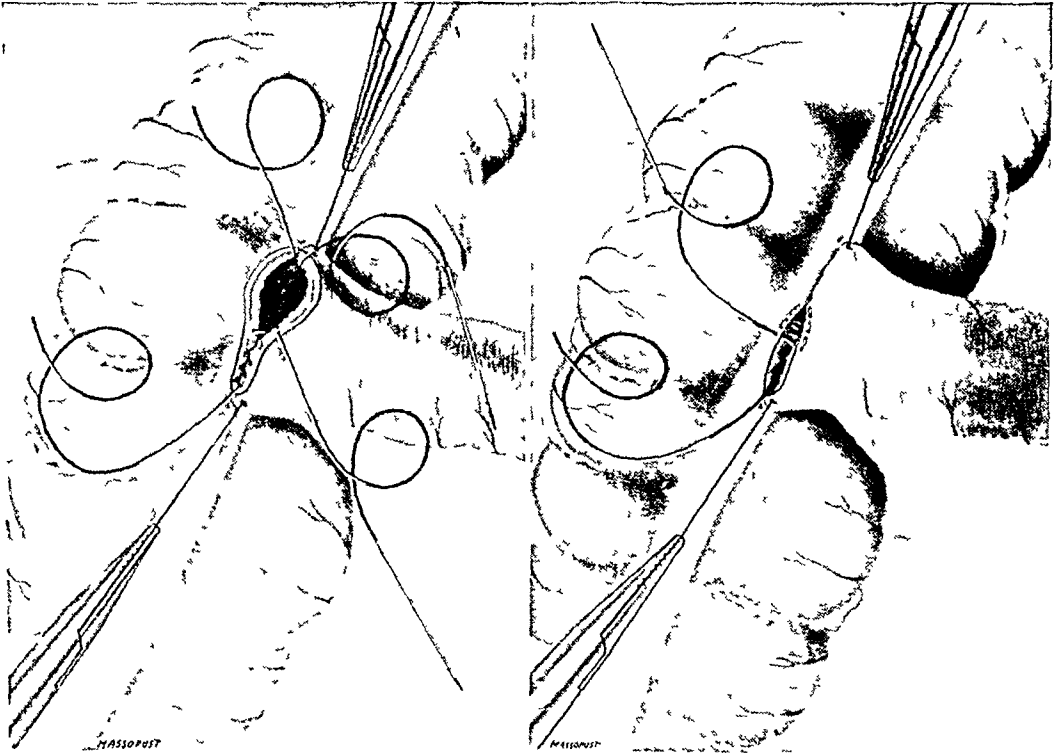
Fig 3 —Anterior portion of the wall of the ileum has been divided at a suitable distance from the crushing clamp The over and over suture used to unite the posterior margins of the mucosa and submucosa is now continued as a baseball stitch to approximate their anterior margins Each stitch is drawn snugly to provide gas and fluid-tight closure and to prevent hæmorrhage from these structures

Fig 4 —End to side anastomosis The continuous over and over catgut suture used to unite the posterior margins of serosa, subserosa, and muscularis now being utilized as a Cushing stitch to approximate their anterior margins and to provide hemostasis in the layers external to the submucosa

to that in which the previous stitch began (Fig 2) Every third stitch includes the margins approximated by the previous stitch (Fig 1, Paragraph 3) and is locked to prevent slipping. Each stitch is drawn snugly to provide hemostasis in the layers internal to the submucosa and to obliterate dead space.

6. Division of anterior portions of walls which have been unsevered in end-to-end and in end-to-side anastomoses and trimming of redundant mucosa in lateral anastomoses. Clamping of such vessels in the anterior wall as bleed profusely and sometimes ligating such as threaten to continue to bleed. This is commonly unnecessary and should be avoided when safe as the ligatures, even of fine catgut, add an undesirable bulk of foreign body.

7. Continuing the mucosa-submucosa stitch (Fig. 3, Paragraph 5) to unite the anterior layers as a baseball stitch (Fig. 3) which affords sufficiently accurate approxi-

mation to assure healing. It is more efficacious in producing unleakable closure and in providing hemostasis than an over-and-over stitch and more easily inserted than others. It is tied to the end left long when the first stitch was inserted in the closure of the posterior margins of the mucosa-submucosa layers.

8. The continuous over-and-over catgut suture (Fig. 4) employed to unite the sero-muscular layers is now utilized as a Cushing stitch to approximate the anterior serosa, subserosa, muscularis, and submucosa. It is tied to the end left long when the first stitch was inserted in the layers posteriorly.

9. Approximation of serosæ anteriorly with interrupted silk mattress sutures. (Fig. 5.) These sutures and the posterior row (Fig. 1) may be omitted if exposure is inadequate or if an emergency demands speed. They add a factor of safety so that the time required to insert them is usually well spent.

10. Approximation of the margins of the apertures in mesentery.

11. Wrapping omentum about the line of intestinal suture.

Illustrations show steps in the application of this method to an end-to-side anastomosis between small and large intestine when the intervening portions of the bowel are to be excised. In the drawing the colon is undivided while the anastomosis is being accomplished. In operations the colon is previously divided, the distal end is ligated after crushing and inverted with two purse-string sutures. The anastomosis is made close to this stump and imitates normal ileocecal relationships and function.

Clamps are employed only for crushing. Those applied to ends that are to be sutured are so placed perpendicular to the mesentery as not to interfere with the blood supply. If an end-to-side anastomosis is to be made, the lateral margins of the

Fig. 5.—End to side anastomosis Suture being completed by approximating the serosæ anteriorly with interrupted silk mattress sutures

intestine are first drawn apart by Allis forceps applied to the walls distal to where the crushing clamp will be placed, thus assuring that the stoma will be as large as the lumen of the bowel will require. End-to-end anastomoses are performed in a similar fashion unless the bowels to be united differ materially in size. Then the larger segment is puckered before being clamped to reduce the disproportions that must be overcome through unequal spacing of the stitches.

Clinical Aspects.—Patients operated upon during the past ten years have been followed as closely as possible and, when feasible, have been subjected to barium X-ray examinations at subsequent intervals.

One death resulted from necrosis of the ileum at the margin of an ileo-colostomy stoma which had resulted from thrombosis of a vein. No other death resulted from faulty healing. The inverted stump of the colon in another patient leaked (proved by X-ray) but as a drain had been employed,

was harmful only in retarding convalescence. The fistula closed spontaneously. Anastomoses in the recto-sigmoid, whether lateral, end-to-side, or end-to-end, seem destined to leak but also to close spontaneously. Otherwise immediate healing has been good.

In patients examined fluoroscopically, some repeatedly, there has been found no evidence of retardation of the progress of the barium at the site of operation, or of local tenderness suggesting the presence of ulcers or manifestations of undue cicatrization. Those subjected to subsequent laparotomy have been found to have no more adhesions than were warranted, some less. The margins of the stomas were soft and pliable and the bowel proximal to the stomas was free from the hypertrophy that would indicate partial obstruction.

NON-EFFECT OF IRRADIATED ERGOSTEROL IN THE TREATMENT OF FRACTURES *

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FROM THE FOURTH SURGICAL DIVISION OF BELLEVUE HOSPITAL

Following the work of Windhaus, Hess and others in the use of irradiated ergosterol [1] in tetany and rickets, where its action is almost specific, the question arose as to the possibilities of this drug in the treatment of fractures. Would it have any effect upon raising the blood calcium and blood inorganic phosphorus above normal, and would it hasten the deposition of callus at the site of fracture?

Irradiated ergosterol is a substance produced by irradiating ergosterol with ultra-violet light and the consequent production of Vitamin D. The product that we have used was supplied to us through the courtesy of the Winthrop Chemical Company. A careful study was made of a series of seventeen cases of various fractures in adults, most of them fractures of the shafts of the long bones. The reason for selecting fractures of the shaft was because it was felt that callus formation could be more carefully observed in the X-rays of the shafts, and because in case of excessive callus formation, it would be best not to have it too near a joint. The majority of the patients were in the hospital during the entire period of treatment, but some were ambulatory and were studied on their return each week to the divisional fracture clinic.

TABLE I

Effect of irradiated ergosterol on the calcium and inorganic phosphorus of the blood in cases of fractures in adults estimated in milligrams per hundred cubic centimeters

Case	Date	Age	Ca Before	Ca During	P Before	P During
(1) I. R.	11–26–28	41	10.22		2.10	
	12–13–28			10.20		2.00
	12–26–28			11.22		2.30
	1–21–29			13.64		1.95
(2) K. F.	11–13–28	58	11.20		2.20	
	12–12–28			11.22		2.20
	12–26–28			12.75		2.50
	1–23–29			13.13		2.00
(3) A. K.	12– 3–28	35–40	10.20		2.10	
	1–23–29			10.70		2.10
(4) J. H.	11–26–28	36	11.10		....	
	12–12–28			11.20		1.80

* Read before the Surgical Section of the New York Academy of Medicine, May 2, 1930.

TABLE I (*Continued*)

Case	Date	Age	Ca Before	Ca During	P Before	P During
(5) J. C.	12–19–28	64	13 13		2.75	
	1–23–29			11.80		2.00
(6) A. McG.	12–26–28	55	12.95		3.40	
	1–23–29			11.80		1.80
(7) M. M.	1–30–29	60	12.75		2.00	
	2–11–29			13.26		2.00
	2–25–29			12.75		2.10
	3–13–29			13.26		2.00
(8) D. H.	2–25–29	70	11.75		2.00	
	3–11–29			11.72		2.12
	3–25–29			13.20		2.00
	4–15–29			12.75		2.10
(9) J. R.	3–11–29	28	12.24		2.00	
	3–26–29			11.22		2.50
(10) P. H.	2–11–29	25	12.75		2.10	
	2–20–29			13.26		2.00
	4–1–29			12.24		2.00
	4–15–29			13.26		2.00
(11) L. R.	2–28–29	35	12.20		2.00	
	3–11–29			12.24		2.00
	3–25–29			12.75		2.10
	4–1–29			10.67		2.20
(12) P. G.	3–25–29	75	12.75		2.10	
	4–1–29			12.24		3.25
	4–15–29			11.72		2.50
(13) L. L.	3–25–29	48	13.26		2.00	
	4–1–29			13.26		2.00
(14) F. G.	3–11–29	43	11.73		2.00	
	3–25–29			13.26		2.10
	4–1–29			12.75		2.67
	4–15–29			12.75		2.10
(15) A. M.	4–1–29	15	13.26		2.60	
	4–15–29			13.26		2.77
	4.29–29			12.75		2.50
(16) M. G.	4–15–29	66	11.22		2.00	
	4–29–29			11.22		2.10
(17) C. McC.	4–15–29	58	12.24		2.27	
	4–29–29			12.75		2.20
	5–6–29			12.75		2.50

X-rays were taken immediately upon admission of the patient, together with a specimen of the blood for estimation of the blood calcium and inorganic phosphorus. As soon as proper reduction of the fracture had been obtained, the patient was started on a daily dose of three and three-tenths milligrams of irradiated ergosterol in olive oil. The ergosterol was given daily for a period ranging in some cases from thirty to seventy days. At weekly intervals X-rays were taken, and determination of the calcium and inorganic phosphorus in the serum were made.

Tisdell's method was used for the determination of the calcium in the blood serum [2] and the method of Benedict and Theis [3] was used for the determination of inorganic phosphorus.

TABLE II

Treatment, type and duration of fracture

Case	Date of Injury	Type of Fracture	Treatment	Irradiated Ergosterol		Fibrous Union	Bony Union
				From	To		
(1) I. R.	11–17–28	Shaft femur *shaft tibia* both bones at ankle	skeletal traction	11–26–28	1–21–29	5–1–29	7–3–29
(2) K. F.	11–1–28	fracture neck left femur	Whitman abduction spica	11–13–28	1–26–29	12–30–29	3–10–29
(3) A. K.	11–29–28	shaft left humerus	skin traction	12–3–28	1–8–29	12–31–28	3–5–29
(4) J. H.	12–30–27	upper third left tibia and fibula	plaster cast	11–26–28	12–12–28	9–17–28	6–11–29
(5) J. C.	12–16–28	fracture both bones right leg	reduction immobiliza- tion, plaster cast	12–22–28	2–1–29	2–1–29	left hospital, not followed
(6) A. McG.	12–20–28	upper third shaft left humerus	skin traction	12–26–28	2–19–29	1–25–29	2–6–29
(7) M. M.	1–27–29	shaft left humerus	skin traction	1–30–29	3–13–29	3–9–29	3–20–29
(8) D. H.	2–23–29	shaft right tibia and fibula	reduction immobiliza- tion, plaster cast	2–25–29	4–26–29	4–31–29	5–6–29
(9) J. R.	3–5–29	supracon- dylar frac- ture right humerus	skin traction	3–11–29	3–28–29	3–17–29	4–22–29
(10) P. H.	2–8–29	fracture left ulna	reduction immobiliza- tion	4–1–29	4–15–29	4–20–29	5–13–29
(11) L. R.	12–7–28	fracture left patella	immobiliza- tion, poste- rior plaster splint	2–28–29	4–1–29	5–2–29	never obtained bony union
(12) P. G.	3–23–29	supracon- dylar fracture femur	plaster cast	3–25–29	4–26–29	4–24–29	*left hospital, not followed*

TABLE II (*Continued*)

Case	Date of Injury	Type of Fracture	Treatment	Irradiated Ergosterol		Fibrous Union	Bony Union
				From	To		
(13) L. L.	2–11–29	fracture left ulna	reduction immobiliza- tion	3–25–29	4–15–29	4–1–29	5–13–29
(14) F. G.	3–8–29	supracon- dylar fracture femur	Steinman pin, skeletal traction	3–11–29	5–27–29	5–14–29	6–30–29
(15) A. M.	3–7–29	both bones of forearm	reduction molded plas- ter splint	4–1–29	4–29–29	4–1–29	4–22–29
(16) M. G.	4–10–29	shaft tibia and fibula left leg	Steinman pin, skeletal traction	4–15–29	5–27–29	5–6–29	6–7–29
(17) C. McC	4–1–29	supracon- dylar fracture femur	Steinman pin, skeletal traction	4–15–29	5–7–29	5–6–29	7–10–29

Discussion.—As is shown in the preceding table, seventeen cases of fractures have been studied. In none of these cases was it found that irradiated ergosterol had initiated or influenced either the degree or rapidity of calcification. Callus formation, both as judged from the clinical stand-point and from X-ray studies, took about the same amount of time as would be expected normally of a fracture of that type. There was no hastening of the union of the fracture in any case nor could an increased amount of callus deposition be observed in any of the X-rays.

Chemical studies of the blood of the patients were made at weekly inter-vals for periods varying from thirty-five to sixty days during which time irradiated ergosterol was constantly administered. It will be seen from the table that the inorganic phosphorus did not materially change in amount during treatment. The calcium, however, showed a slight but definite increase in some of the cases. Using the results where treatment was given for the longest periods, we find the following increases in calcium in milligrams per hundred cubic centimetres:

I. R.	10.22	13.64	plus 3.42
K. F.	11.20	13.13	plus 1.93
M. M.	12.75	13.26	plus 0.51
D. H.	11.72	12.75	plus 1.03
P. H.	12.75	13.26	plus 0.51
F. G.	11.73	12.75	plus 1.02
L. R.	12.20	10.67	minus 1.53

In all of the above, except L. R., there is a slight increase in the calcium. According to Tisdell and Harris,[4] however, these increases are within normal

range, as they found, in studies of a year's duration on healthy adults, that calcium and phosphorus retention does not run parallel, and also that certain definite and important changes in the inorganic metabolism almost always accompany any process of bone repair. Therefore, it is questionable whether the increase as noted can be attributed to the influence of the irradiated ergosterol which was administered.

Outside of the medication the fractures were treated in our accustomed manner. Four cases of fracture of the shaft of the femur were treated with skeletal traction with a Steinman pin just above the condyles of the femur, followed by a plaster spica, and then with weight bearing, in some cases with an ambulatory Thomas's splint. Two cases of fractures of both bones of the leg with marked overriding were treated by skeletal traction with a Steinman pin inserted through the os calcis, followed by a plaster case as soon as fibrous union had occurred. Four cases of fracture of the humerus were treated by skin traction with mole skin, and one case of fracture of the patella with only slight separation of the fragments was treated by immobilization for six weeks with a posterior molded plaster splint.

One case of fracture of the neck of the femur (K. F.) was followed with special interest. The usual Whitman abduction method of reduction and immobilization in a plaster spica was followed. No increase in the rapidity of callus formation could be noted. Unfortunately, this case was transferred to another hospital and was lost sight of after the first ten weeks.

· The remaining cases were reduced at the time of admission and immobilized in plaster.

All cases were given occupational therapy following the period of immobilization.

Cases of delayed union.—In this group there were six cases that may be considered ones of delayed union. Four of these were fractures that had been present for periods varying from six weeks to eleven months before irradiated ergosterol was started, and in all of which no bony union had occurred. In none of these cases was there any deposition of bony callus during the administration of the medication, either clinically or by X-ray study. These four cases are as follows in Table II:

Case No. 4.—Fracture of upper third tibia and fibula. Present for eleven months before medication. Only fibrous union.

Case No. 10.—Fracture left ulna. No union after fifty-one days. No effect from medication.

Case No. 11.—Fracture of patella. Not operated upon because of skin abrasions and contusions. No union after two and a half months. No effect from medication.

Case No. 13.—Fracture left ulna. No union after six weeks. No effect from medication.

Two cases in this group were ones in which the treatment was started shortly after the fracture occurred and in both of which delayed union occurred anyway. Case No. 1 was kept on the irradiated ergosterol for two

months with no apparent result and bony union did not occur for nine months. This patient had three separate fractures, as is shown in Table II.

Case No. 3 was a fracture of the lower third of the shaft of the left humerus. Treatment was started immediately and medication was continued for about five weeks with no result. Ultimate bony union did not take place until March 5, 1929.

It can, therefore, be seen that whether the delayed union was already present or whether it was a subsequent finding, no benefit was obtained from the use of irradiated ergosterol. Wassermann reactions in all of these cases were negative and there were no factors that could be found as etiological factors in the cause of the delayed union.

CONCLUSION

1. Irradiated ergosterol does not hasten union or callus formation in fractures in adults.

2. Irradiated ergosterol does not materially raise the calcium and inorganic phosphorus in the blood of adults suffering from fractures. An average rise of only 1.4 milligrams of calcium was obtained and the phosphorus showed relatively no change.

3. Delayed union was present in six cases and no benefit was obtained by using irradiated ergosterol.

4. Irradiated ergosterol cannot be considered of value in the treatment of fractures in adults whether union be delayed or not.

(My thanks are due to Miss Florence S. Tabor who did the blood chemistry work involved in the above studies.)

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INTRAARTICULAR ENDOTHELIAL TUMORS ARISING FROM SYNOVIAL MEMBRANE

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Definitely encapsulated tumors arising from within joints are rare occurrences. A careful search of the literature reveals few instances that have been reported and none have been reported with a complete pathological diagnosis with suggestions as to origin and treatment.

Classification.—The etiology is obscure but these tumors are considered as neoplasms. Syphilis, tuberculosis and focal infection or blood diseases

Fig 1 —X-ray showing soft tissue shadow definitely outlined filling anterior space of knee-joint.

Fig. 4.—X-ray of ankle showing soft tissue tumor in anterior space of ankle-joint.

such as anæmia, leucemia, etc., can be ruled out, as the patients are apparently in the best of health. The blood chemistry with special attention directed to cholesterin showed no variation from the normal. Trauma is not considered a factor in the etiology of these tumors but can produce secondary changes in the joint, due to pressure or invasion of the adjacent structures by their slow growth. They are considered primary in the joint as they show no involvement of the lymph structures or in other parts of the body.

Pathology.—When one explores a joint so affected, the cartilage and ligaments intact, one is impressed to find a tumor that has adapted itself

to the shape of the joint-space it occupies. The tumors are definitely encapsulated and their only attachment is to the synovial membrane. They have a yellow and brownish tinge as to color, resembling the color of synovial membrane, and to the touch they are resistant as in kidney tissue, therefore very cellular. On cut surface (Fig. 5) the increased pigment is shown near the center in small islets. The histological picture (Figs. 3 and 6) shows the tumor composed of peculiar, elongated, blunt cells, sometimes fusiform in shape, lying closely together. The nuclei are round and oval in shape. In certain zones the fibrous tissue seems to exceed the cellular elements. Numerous mitotic figures are noted and one would think we are dealing with an atypical sarcomatous growth. Because of the coloration of the tumor, special stains were used in further study of the section and its relation to the xanthomatous group was completely ruled out; and I believe the final judgment can be left to Doctor Ewing's discussion: *"I should think that the*

FIG. 2.—Shows tumor definitely outlined, which was removed from knee-joint.
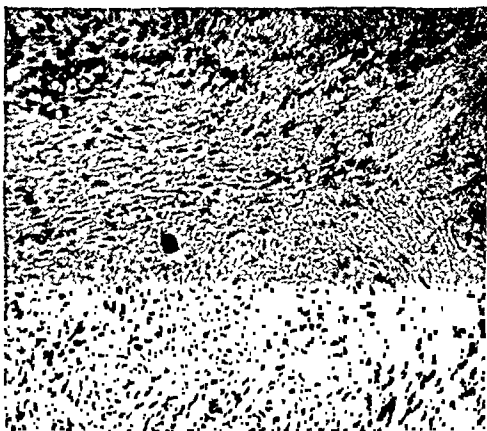
FIG. 3.—Photo-micrograph of tumor of knee-joint showing peculiar elongated blunt cells lying closely together; occasional mitotic figures are found.

diagnosis of fibro-endothelioma was correct. In the last microscopical picture shown there were groups of isolated cells, which would hardly be consistent with a fibroma and which have a somewhat polyhedral form. I would not venture to make a diagnosis on the lantern slides alone, if I had not seen in the past three months three cases very similar to these; one from Doctor Bloodgood, one from Doctor Smith, of Harvard, and another of our own. They show a variety of structures, but, in a general way, the picture approaches the cases which Doctor Wagner has just presented. The position of the tumor is strongly suggestive of an origin from the endothelial cells lining the bursa. There is no doubt that the bursal endothelioma is capable of extensive proliferation producing tumors of this same general character."

Clinical classification.—This type of tumor is certainly most rare. It has no particular selection for any particular age or sex, therefore occupations would have no bearing or predisposition as to such tumors. It has been noticed but on two occasions in the study of 467 explorations of major

joints of the body, extending from the year 1900 to 1930, as taken from the private files of the late Dr. Virgil P. Gibney and myself.

The symptoms are marked by the ever-presence of pain, which is of a dull, aching character, and the patients walk with a limp. They cannot seem to find a comfortable attitude for the affected joint. The cases are first diagnosed as a chronic synovitis, as they so much resemble this condition.

Diagnosis.—These cases are very difficult to diagnose, especially when the tumors are small. There is swelling in only one part of the affected joint. There is no particular tenderness nor increase of synovial fluid. The range of motion is very rarely affected, because there is no change in the articular or periarticular structures. The diagnosis is further augmented by the *careful study of the X-rays with special attention to soft tissue structures* (see Figs. 1 and 4).

Treatment.—The treatment is surgical and, although a complete enucleation may be secured, they are prone to recur. X-ray treatment or Coley's toxin may be tried, but so far no cures are reported. The tumors are removed as often as they recur and usually end with amputation of the affected extremity, which brings about the final cure.

Case I.—An adult, thirty-five years old, a musician, with an irrelevant family and past history, without any apparent cause began to complain about ten years ago of pain in the right knee. It was treated with the usual rheumatic treatment by the family physician but with no improvement. In the summer of 1923 he consulted a surgeon and the limb was immobilized in plaster without any relief of symptoms. The patient came under the care of Doctor Gibney and myself in October, 1923. Examination showed him to be in good condition but he was walking with a slight limp, although the functions of the right knee were not impaired. There was a one-inch difference in the measurement of the knees, with a slight fullness under the right patella tendon, which was slightly tender. He brought a report of X-ray findings, which were normal, although I did not see the pictures. The case was thought to be one of chronic synovitis, especially of the retro-patella sac, and was treated conservatively with cautery and strapping. He did not improve but, rather, the pain became worse and extremely so in wet weather, so that it required codeine for relief. In January, 1924, an X-ray (Fig. 1) was taken, which showed a mass behind the patella tendon that was thought to be hypertrophied synovial tissue, but a definite tumor was not considered. On look'ng back it can easily be recognized. On February 13, 1924, the patella was split and the knee-joint exposed. A solid tumor covered by a synovial veil lay in the knee-joint. It was attached to the outer antero-inferior border of the capsule by a small attachment. The tumor (Fig. 1) was so large that it was divided longitudinally to facilitate removal and shelled out with little difficulty. The knee-joint was normal otherwise. The tumor (Fig. 2) measured 7 by 5 by 3 centimetres, was elliptical in shape, and surrounded by a definite capsule. It was hard, and a diagnosis of benign fibroma was made from the gross examination. Under the microscope the tumor shows peculiar, elongated blunt cells lying close together. Mitotic figures, although few, were seen. It was thought to be a very atypical fibro-sarcoma but I believe it is a fibro-endothelioma arising from synovial tissue. The patient was free from pain for one year when the tumor reappeared on the lateral surface of the knee. An extensive resection was done of the capsule of the joint and the patient was again free from symptoms after the second operation. He received extensive X-ray therapy by Dr. Francis Carter Wood and a thorough course of Coley's toxin. In 1926 the symptoms and signs reappeared. The

tumor had invaded the upper end of the tibia, under the patella tendon. Resection was unsatisfactory at the third operation and two weeks later a mid-thigh amputation was done. Examination, March, 1930, showed patient well and free from recurrences or metastases. No further treatment.

CASE II.—A girl, fifteen years old, has complained of a swelling and pain on the anterior surface of the right ankle-joint for about six years. She has been treated by various clinics for synovitis. Examination is negative except for the right ankle-joint. The anterior surface of the ankle-joint shows a semi-solid, movable tumor right under the tendons on the dorsum of the ankle. X-rays (Fig. 4) show a definite soft tissue mass anterior to the ankle-joint. An arthrotomy was performed February, 1929, and a tumor measuring 6 by 3 by 2 centimetres was removed. It was attached to the synovial membrane of the ankle-joint. It was kidney-shaped and brown and yellow-tinged, smooth and definitely encapsulated. To the touch it was solid as in kidney tissue and therefore very cellular in substance. Microscopically it was composed of peculiar, elongated, blunt cells lying close together. No mitotic figures were seen. It is thought to be

FIG. 5.—Photograph of cross-section of tumor of ankle-joint showing the increased pigment towards the center of tumor and compactness of the tissue elements.
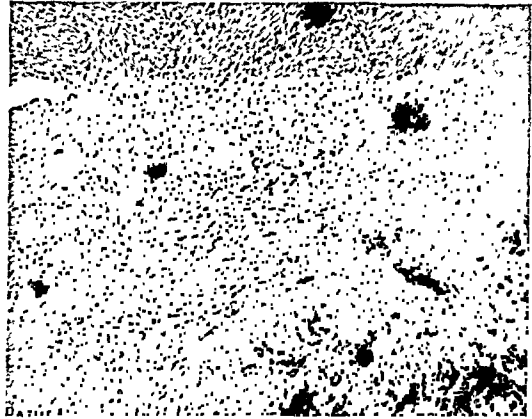
FIG. 6.—Photo-micrograph of tissue from tumor of ankle showing groups of cells which are identical with Fig. 3 and hyaline degeneration is also represented.

synonymous with a fibro-endothelioma arising from synovial tissue. It is difficult to give a prognosis as Case I ended in amputation of the leg because of the recurrence in the knee-joint. Examination in March, 1930, showed no recurrence so far to this date, although the patient is beginning to complain of a little pain which usually precedes the appearance of the tumor.

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MULTIPLE MYELOMA AS A SINGLE LESION

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In a recent publication in the *Archives of Surgery* for April, 1928,[1] on multiple myeloma, a complete review was given of the literature and thirteen case reports added from the Surgical Pathological Laboratory of the Johns Hopkins Hospital. In this paper an analysis was made of the symptoms and findings in all the cases which were available either in the literature or in this laboratory. For purposes of diagnosis attention was called to six cardinal features of the disease which were usually found present collectively or in pairs or triads in any individual case. These six cardinal diagnostic features of multiple myeloma were (1) multiple involvement of the skeletal trunk by tumor formation in an adult over thirty-five years; (2) pathological fracture of a rib; (3) the presence of Bence-Jones bodies in the urine; (4) lumbar backache with signs of early paraplegia; (5) an otherwise inexplicable anæmia; (6) a chronic nephritis with nitrogen retention and low blood-pressure.

The case to be reported here is presented, not from the angle of adding another case to the literature, but in order to call attention clinically to the exceptional case of multiple myeloma which breaks all the usual rules for the diagnosis of this disease. In this recent case, not one of the six diagnostic features listed above was present. The patient had but a single bone lesion. The ribs were uninvolved by the disease. The urine was negative for Bence-Jones bodies and there were no symptoms referable to the spine or to the central nervous system. The patient's hæmoglobin and red blood cell count were within normal limits and clinically he was without signs of nephritis. The case report follows:

The patient (C. S.—Path. No. 42108) was a white male, aged forty-five, and a hotel steward by occupation, who had always enjoyed good general health. He gave an essentially negative family and past history. The present illness began two months previously, when he first noticed pain in the upper third of the left thigh, on lifting a pile of heavy dishes. The pain, which lasted about one week, was severe, drawing in character and radiated down the left thigh. It caused him to limp, and this disturbance of function persisted. Two treatments were given by a chiropractor without benefit, and after two weeks a medical practitioner gave tablets and liquids without relief. One month before admission to the hospital because of continued pain, a surgeon was consulted, an X-ray was taken and operation was advised, although no diagnosis was rendered.

On examination of the patient, October 10, 1929, practically no positive findings were disclosed. The general physical examination was negative. There was no visible or palpable swelling over the painful area and practically no tenderness to pressure. There were no enlarged glands in the region. The only difference between the left thigh and the normal was the subjective pain and the noticeable limp on walking. The neurologi-

cal examination was negative. The prostate was normal to palpation, and no symptoms referable to the genito-urinary tract could be elicited. The blood examination showed Hæmoglobin 85 per cent.; red blood cells 4,930,000; white blood cells 13,000; with differential count, 81 per cent. polymorphs; 13 per cent. lymphocytes; 6 per cent. mononuclears and transitionals. The blood-pressure was 115/72 mm.

The urine examination was negative except for a trace of albumin and a rather high specific gravity. The examination for Bence-Jones bodies was negative.

The most significant findings were brought out by röntgenologic studies. The X-ray of the left femur (see Fig. 1) showed an area of medullary bone destruction in the upper shaft at the site of the nutrient artery extending from the intertrochanteric line to the beginning of the middle third of the femur. About this area the cortical bone was everywhere intact, without any signs of disturbance of the periosteum. The shadow of rarefaction faintly resembled a confluence of three separate areas, but this was not distinct enough to warrant an opinion that the lesion had begun in more than one

FIG. 1.—P. N., 42108. X-ray of the femur in multiple myeloma appearing clinically as a single lesion, in a white male aged forty-five. There were no symptoms except pain and limping of two months' duration. The X-ray shows a central area of bone destruction at the site of the nutrient artery with an intact shell of cortical bone. There is no periosteal reaction.
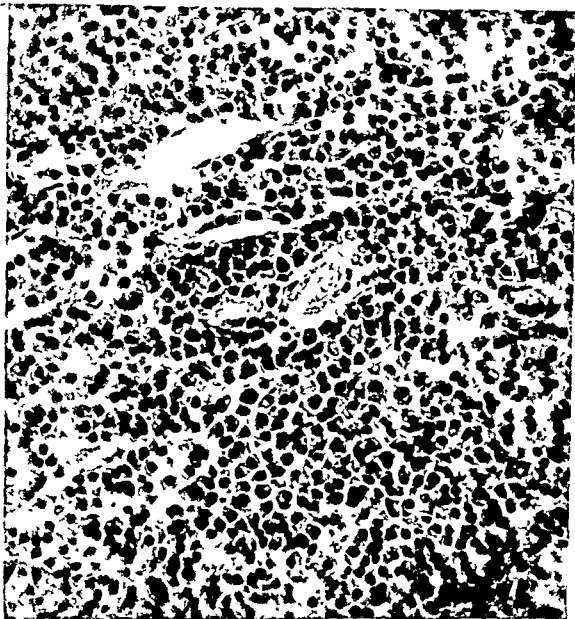
FIG. 2.—P. N., 42108. Photomicrograph of tissue removed at biopsy from the same case shown in Fig. 1. The high power shows cells with a clear cytoplasm and an eccentrically placed nucleus. The chromatin in the nuclei frequently has a spoke-like arrangement. The cells are unusually closely packed and the tissue is rich in young capillaries. This is the so-called plasma cell type of multiple myeloma.

focus. X-ray examination of the other long bones, the pelvis, and the spine was negative. There was no evidence of metastases in the lungs; the ribs were essentially normal. The skull was negative.

The clinical diagnosis rested between a metastatic carcinoma to bone (probably · hypernephroma) or an unusual myxochondroma arising in the neighborhood of the lesser trochanter. The intact shell of cortical bone did not favor a myxochondroma at this site. The absence of involvement of the skeletal trunk, and the single area of bone involvement were against multiple myeloma. Exploration was advised and at the operation performed by Doctor Bloodgood, the affected area of bone was exposed showing an essentially normal periosteum and cortex. There was, however, unusual vascularity and much hæmorrhage was encountered in stripping the periosteum. On opening the bone shell a mass of semifluid, red and yellow tumor mixed with much blood poured from the wound. A uniformly red and spongy mass lined the cavity, resembling

in consistency a firm and partly organized blood clot. Continual packing was necessary to check hæmorrhage which did not cease until the tumor lining had been stripped from the cavity. The cavity was cauterized with the electric cautery, and sponged with gauze wet in 50 per cent. zinc chloride. The cavity was packed with iodoform gauze and the wound closed with silver wire. A Thomas splint was applied to avoid fracture.

Frozen sections made at the time of operation showed a tumor composed of an uniform sheet of cells resembling the plasma cell. A microscopic diagnosis of multiple myeloma of the plasma-cell type was made and confirmed later by permanent sections (see Fig. 2).

Pathologic fracture occurred shortly after the operation through the affected area which healed under proper treatment. The patient returned home four months after the operation and had a second pathologic fracture in March, 1930. Repeated examinations of the urine for Bence-Jones bodies made during the patient's stay in the hospital were negative. The patient is gradually losing ground despite deep X-ray therapy and Coley's toxins.

This case is remarkable for the brief duration and simplicity of the symptoms and physical findings. Pain and limping for two months, referable to the left thigh, were the only positive findings in the history. In addition the X-ray showed but a single bone lesion. Other than the microscopic section, the only evidence in favor of a diagnosis of multiple myeloma was the distinct medullary origin of the tumor in a portion of the skeleton where red bone marrow is present, the age of the patient, which was over thirty-five, and the extreme vascularity of the tumor at exploration. Although it is too recent at this time to determine whether or not the other bones of the skeleton will show clinical involvement, it is safe to presume that the disease will progress and disseminate despite the treatment administered. There is on record another case similar to this one which supports this statement. This is a case which came under the observation of Dr. George Crile and which was seen in consultation by Doctor Bloodgood and diagnosed multiple myeloma microscopically by Welch, Bloodgood and MacCallum. The case has been referred to by Bloodgood in "Progressive Medicine" for 1906,[2] and is abstracted as Case 11 in the author's contribution referred to above.

This second case of Doctors Crile and Bloodgood (P.N. 7232) was a white man aged thirty-seven, with a history of pain, following a trauma fourteen months previously. Tenderness and swelling were present in the right clavicle and the X-ray showed a lesion in the outer third of this bone which produced a rarefied area accompanied by expansion of the bone shell. Nothing could be seen in any other bone, and there was no anæmia. The urine was not examined for Bence-Jones bodies prior to operation, but when a biopsy was made and multiple myeloma reported from the frozen section, the patient was catheterized and Bence-Jones bodies were readily demonstrated in the urine. The complete clinical follow-up of this case is on record. The ribs were subsequently involved; there was evidence of extension of the disease to the skull and the patient died six months after the operation.

These two cases substantiate the claim for consideration of multiple myeloma in the differential diagnosis of single bone lesions, when these lesions occur in an adult over thirty-five and are distinctively medullary and bone destructive in character. It is important to bear in mind however, that the site of the lesion is always confined to the red marrow bones.

The usual solitary bone tumor producing a distinctly central area of rarefaction in a long bone .in an adult is either a giant-cell tumor in an epiphysis or a metastatic carcinoma in the shaft of the bone near the site of the nutrient artery. There should be no difficulty in distinguishing between multiple myeloma and a giant-cell tumor. Multiple myeloma practically never occurs primarily in an epiphysis which is the favorite site of the giant-cell tumor.[3] More accurately, the location of the giant-cell tumor is

FIG. 3.—P. N., 37708. X-ray picture of a typical giant-cell tumor in the lower end of the radius, occurring in a white female aged thirty-one. There had been a trauma one year previously, followed by pain. The lesion is too far advanced to show the typical asymmetry but it occupies the epiphysis where it has nearly completely destroyed the bone shell. This lesion recurred after curetting, but was cured by resection and has remained well over two years.

subcortical and the healing reaction in the bone shell permits an asymmetrical expansion. In addition the three most frequent locations for the giant-cell tumor—the upper end of the tibia, the lower end of the femur and the lower end of the radius—are not at the site where red bone marrow is found (Fig. 3).

There is no way to diagnose clinically between multiple myeloma as a single lesion and a metastatic carcinoma of the bone (Fig. 4). Both are

primarily central bone destructive lesions. Bence-Jones bodies in the urine of multiple myeloma patients occur more frequently (approximately 65 per
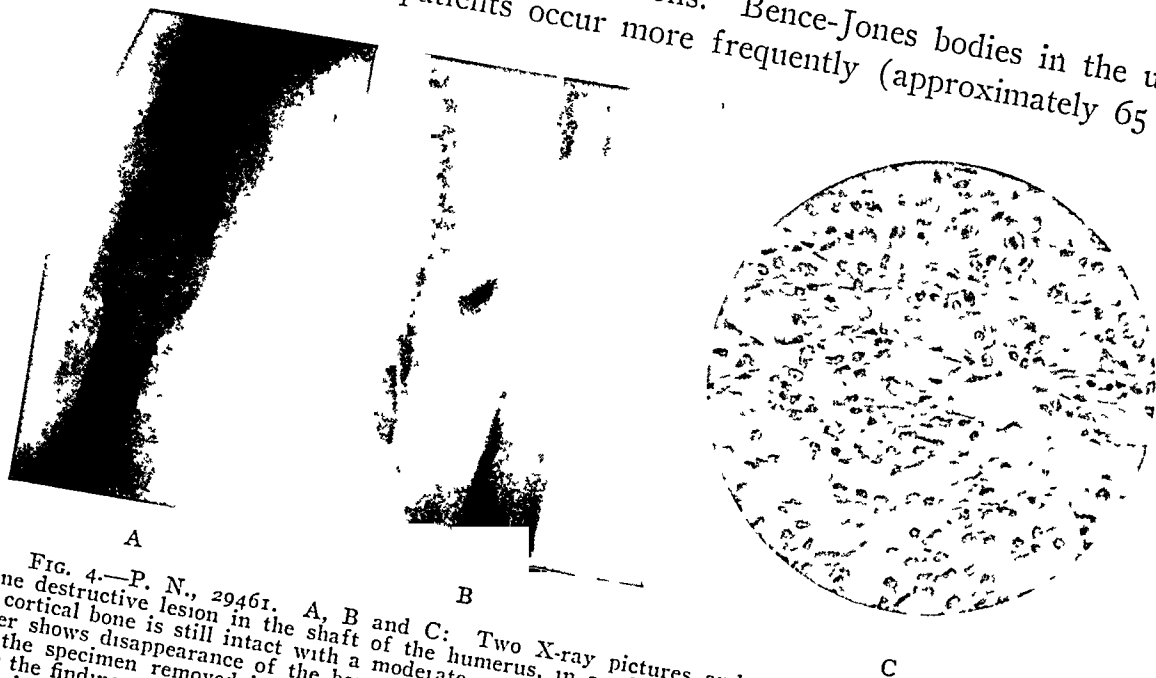
FIG. 4.—P. N., 29461. A, B and C: Two X-ray pictures and a microphotograph of a central bone destructive lesion in the shaft of the humerus, in a white female aged fifty-five. In A the shell of cortical bone is still intact with a moderate amount of expansion. In B the X-ray taken two months later shows disappearance of the bone-shell with increased size of the tumor. Microscopic examination of the specimen removed by amputation showed a hypernephroma. The unusual feature in this case was the finding of Bence Jones bodies in the urine. This is the only case on record of a hypernephroma, showing Bence Jones bodies. The patient died eight months after operation. C shows the typical microscopic structure of the hypernephroma.

cent.) than in patients with metastatic bone lesions, but these bodies may be absent in multiple myeloma or rarely present in cases of metastatic car-
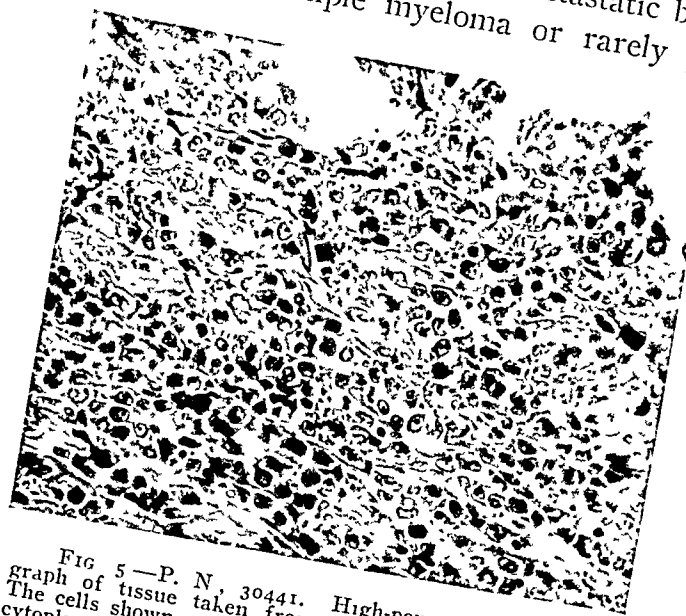
FIG. 5.—P. N., 30441. High-powered microphotograph of tissue taken from a patient with chloroma. The cells shown are of the myelocytic variety with less cytoplasm than the typical myeloma cell. There is less chromatin in these nuclei and a more definite nucleolus. The cells however have the same general arrangement as myeloma. The patient was a white male adult with bone lesions in the femur, humerus and pelvis. The white blood cell count showed a typical myelogenous leukemia. The disease pursued a rapidly fatal course.

FIG. 6.—P N., 29286. X-ray picture of the tibia of a white female age twelve, with a painful tumor of seventeen months' duration. This is the typical rontgenologic appearance of a Ewing's sarcoma. There is expansion of the shaft of the bone produced by thickening of the cortex which is reacting to tumor evasion. The periosteum is raised in parallel layers, giving the so called onion layer appearance. This patient is alive six and one-half years after amputation.

cinoma in the skeleton. These rare cases of Bence-Jones bodies in the urine of cases other than multiple myeloma have been tabulated in a previous

article.[1] Clinically the metastatic tumors to bone are more usually single lesions, and, in addition to the discovery of the primary site of the carcinoma, most often in the breast, the prostate, the thyroid or the kidney, this fact aids in making a diagnosis. Metastatic carcinoma is less frequent in the ribs or clavicle than multiple myeloma, and terminates more often with pulmonary involvement.

Very rarely a single bone destructive tumor arising near the orbit will simulate multiple myeloma under the microscope (Fig. 5). These tumors, when freshly incised, have a greenish hue and the blood count of the patient usually shows a definite leucemia. The tumor is known as a chloroma. The most important point in the differential diagnosis in such a case is the

FIG. 7.—P. N., 31419. X-ray of the lower tibia of a white male age fifty, showing a tumor of twenty-five years' duration. The X-ray shows an area of central bone destruction in the marrow cavity of the metaphysis, extending partially into the epiphysis. The lesion is well circumscribed and there is a thick shell of cortical bone. This is a typical latent bone cyst which healed and completely ossified three and one-half years after curetting.
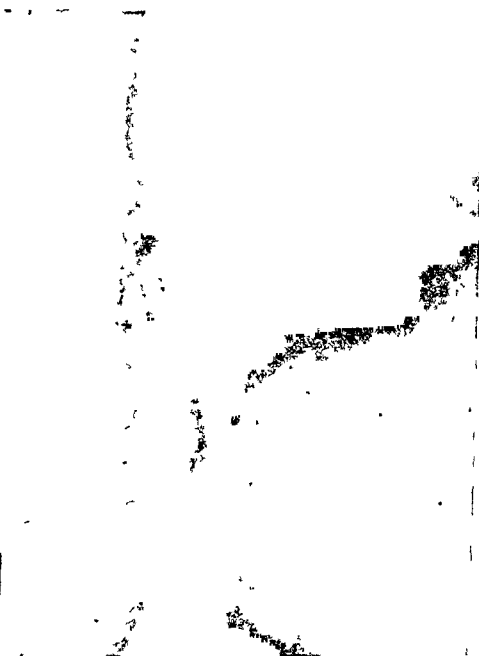
FIG. 8.—P. N., 33423. X-ray of a myxo-cartilaginous tumor in the upper femur of a white male age forty-nine. There had been a trauma two years previously and pain of one year's duration. The X-ray shows an area of bone destruction with a perforated bone shell at the site of the greater trochanter. The lesion recurred after many curettings and cauterizations (over 15). The patient despite amputation finally died six years after the onset of the disease.

white blood cell count. The clinical picture of these very rare cases of chloroma has been ably described in an article by B. Brannan in the Johns Hopkins Bulletin.[4] These skeletal lesions associated with a leucemia are frequently multiple and may have the same distribution as multiple myeloma.

Ewing's endothelial myeloma which occurs in younger patients and is extremely rare after thiry-five years of age, has been frequently described in the literature as a medullary and bone destructive tumor. Studies made in this laboratory[5] do not confirm this contention and point to the fact that the Ewing tumor is generally intracortical or subperiosteal in origin and

is usually bone destructive in only the later stages. The typical X-ray picture of a Ewing's sarcoma (Fig. 6) shows the bone of a patient between fifteen and twenty years of age in which the shaft of a long bone has been
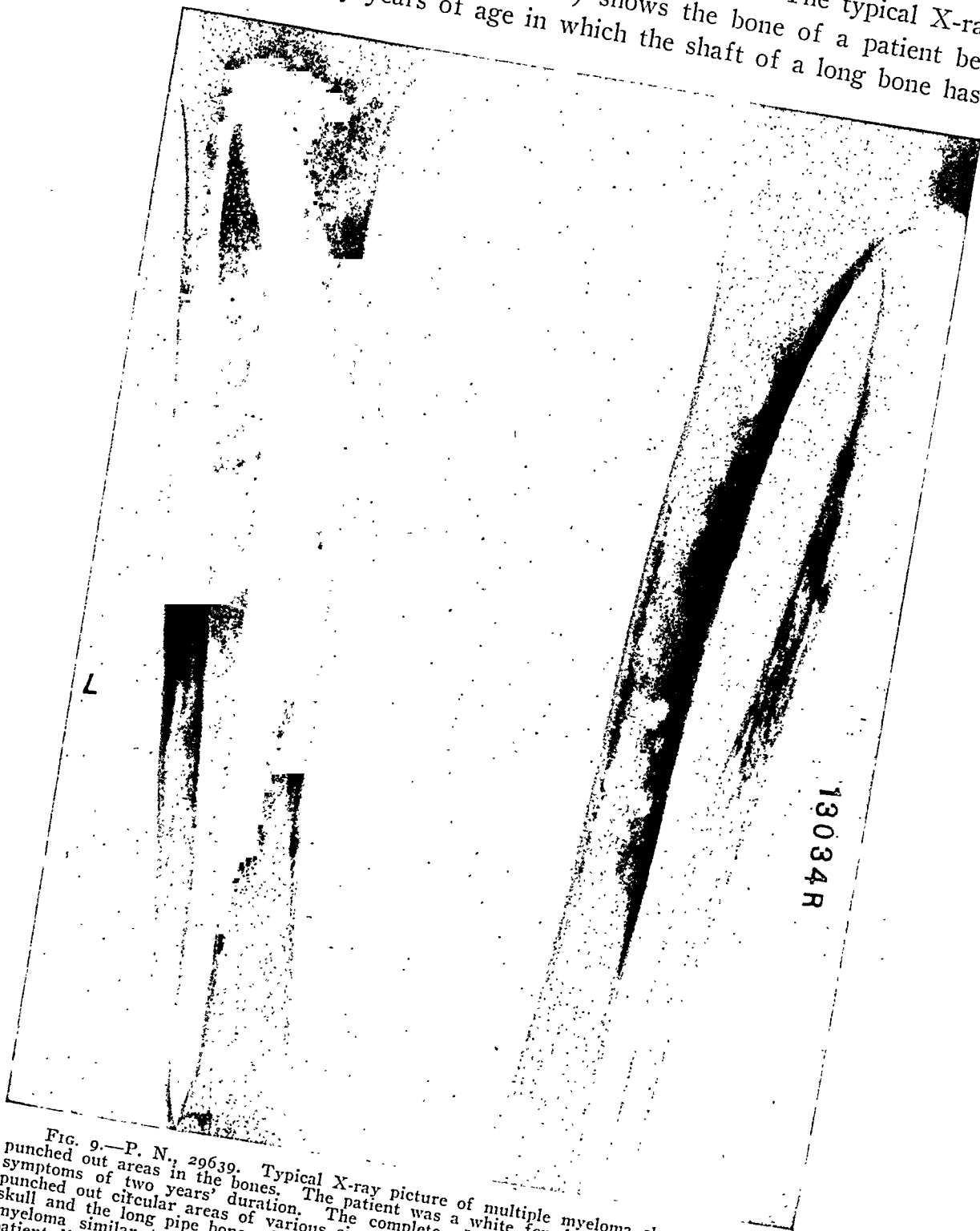
FIG. 9.—P. N., 29639. Typical X-ray picture of multiple myeloma showing multiple punched out areas in the bones. The patient was a white female aged seventy-two, with symptoms of two years' duration. The complete röntgen examination showed over 56 punched out circular areas of various sizes, scattered through the spine, the sacrum, the skull and the long pipe bone. The microscopic examination showed a typical plasma cell myeloma similar to Figure 2. The urine was positive for Bence Jones bodies. The patient died shortly after coming under observation.

symmetrically widened by new bone formation laid down by the reacting cortex. The reacting cortex frequently encroaches upon the marrow cavity and often the bulk of the tumor is found beneath the periosteum above the

cortex. This X-ray picture with its actively reacting cortical bone (the new bone is not of tumor origin) is in sharp contrast to the multiple myeloma which gradually destroys the cortex from within, without producing new bone formation. The occurrence of Bence-Jones bodies in the urine of a patient with a Ewing's tumor has never been recorded to my knowledge.

Occasionally a latent bone cyst walled off in the medullary cavity of a long bone in an adult will simulate the unusual picture of multiple myeloma described here (Fig. 7). However, the shell of bone about the latent bone cyst usually has a thick and competent defensive appearance, whereas in the X-ray of multiple myeloma there is progressive thinning of the cortical bone until fracture occurs. The typical bone cyst occurs in much younger patients between the ages of ten and twenty years, and the bone sites are usually in the metaphyseal regions in those bones most frequently affected by giant-cell tumor. The difference in this distribution is that the bone cyst is rarer in the lower radius and more frequent in the upper humerus than the giant-cell tumor.

In rare instances a myxochondroma, either predominantly a chondroma or a myxoma, will resemble the unusual case of multiple myeloma. These myxochondromas, however, have their origin near the tuberosity of some bone and, if not actually a periosteal lesion, are usually asymmetrically situated on the side of the tuberosity (Fig. 8). They are more apt to have a trabeculated structure in the X-ray and to produce a palpable swelling clinically. They occur in the same age groups as multiple myeloma does, but the duration of symptoms in these fibrocartilaginous tumors is longer. From a histogenetic point of view the chondromas and myxomas are not to be considered primarily central tumors of the long pipe bones. However, they do form central tumors in the small bones of the hands and feet, which is their most frequent location.

·When multiple myeloma is present in the typical form with involvement of the skull and bones of the trunk, the differential diagnosis is much simplified. The disease in its early stages is characterized by rheumatic pains about the chest or in the lumbar region. Pathologic fracture frequently occurs (62 per cent.) and the bone most often thus affected is a rib. Multiple bone involvement visible in the X-ray as circumscribed, central, punched-out areas is the rule. Palpable yielding tumors which may pulsate or crepitate are found in the ribs, the spine, the skull, the pelvis or in the extremities about the pelvic and shoulder girdles. Deformity in the spine with shortening of stature and signs of paraplegia occur. Anæmia of a relatively severe grade and Bence-Jones bodies in the urine are typical laboratory findings. Chronic nephritis is present in 70 per cent. of the cases and a progressive downward course with a fatal termination is the invariable outcome (see Fig. 9 and Fig. 10).

In conclusion, it is important to record here that a primary bone destructive lesion occurring centrally in a single bone, in the shaft of an adult, without expansion of the bone shell, should always excite the suspicion of

malignancy. Rarely the lesion may be a latent bone cyst, most frequently it is a metastatic carcinoma, but occasionally it is a multiple myeloma. The entire skeleton and the lungs should be X-rayed, for in this way the multiple myeloma or metastatic bone tumor, which are both hopeless diseases, may be disclosed, and an unnecessary operation avoided. The urine must not fail to be examined for Bence-Jones bodies.
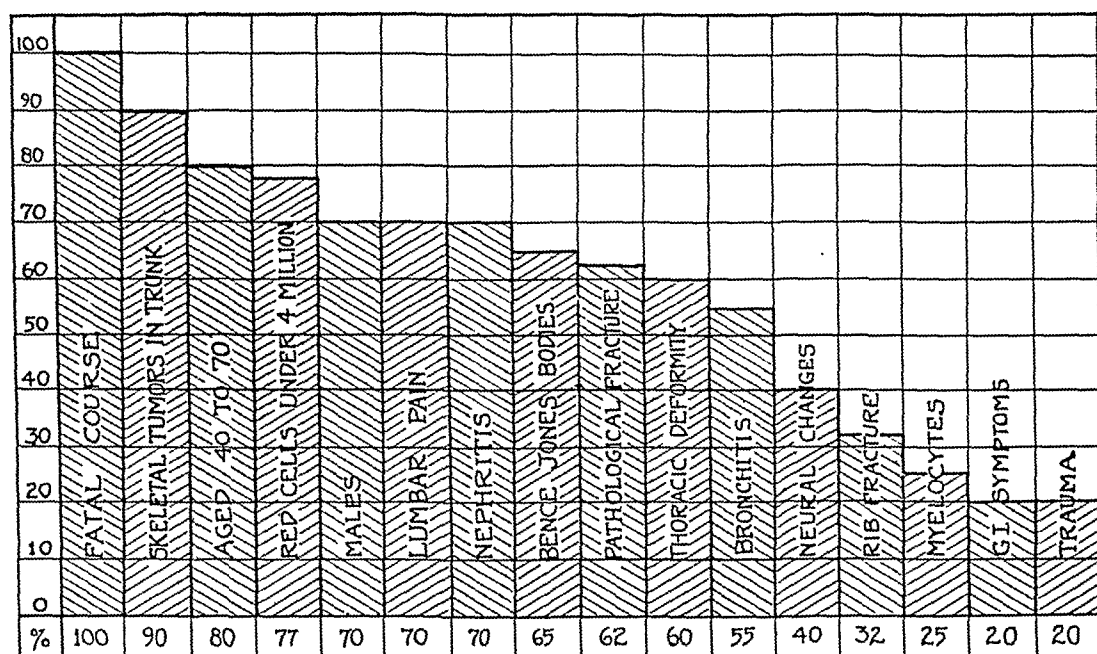
FIG. 10.—Chart showing the incidence by percentage of the leading symtoms of multiple myeloma. Reproduced from the Archives of Surgery, vol. xvi, p. 846, 1928.

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MALIGNANT TUMORS AND THEIR METASTASES

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This brief review of a series of malignant tumors was collected from the autopsy protocols of Bellevue Hospital, New York City, and covers a period of twenty-three years. During that time, 13,500 autopsies had been performed, and out of that number 865 were done on malignant tumors, approximately 6 per cent. Of these tumors, 770 were of epithelial origin, while ninety-five arose from connective tissue, a ratio of eight to one.

The object of this paper is to emphasize the end-results in malignant tumors, as seen at necropsy, particularly their anatomical distribution and the distribution of their metastases. For purposes of description, metastases in this series have been divided into three groups: (1) local, in which the neoplasm confined itself to the organ in which it arose or metastasized, only to immediately adjacent structures or lymph-nodes; (2) multiple local, in which the growth invaded, probably by direct extension, the neighboring organs and structures; (3) diffuse, in which the tumor not only invaded the neighboring tissues, but, in addition, metastasized to some remotely placed organ or structure.

TONGUE.—Nine cases, all males, average age fifty-one years, youngest forty-one, oldest sixty-one. The majority of these tumors involved the regional lymph-nodes, while only about 30 per cent. invaded distant structures, as the lung, heart, liver and brain.

ŒSOPHAGUS.—Of the eighty-three cases, all but two occurred in males—eighty-one males, two females. This interesting sex ratio checks up very closely with the surgical records of the first division, for out of forty cases from which tissue was taken for biopsy, all but one occurred in males. Carcinoma of this structure seems to be associated with the latter decades of life, as the average was sixty-one years, and in only twenty-three cases did it occur below fifty. In the majority of cases this neoplasm showed a marked tendency to remain local, invading usually the immediately adjacent structures, as the lymph-nodes, lungs and liver. Occasionally, regardless of age of patient, or morphology of tumor, these tumors widely disseminate themselves throughout the body, but this is the exception and not the rule. The fact that the majority of these tumors are of local growth may be due to the fact that ulceration and obstruction probably occur early in their course,

and the resultant infection and starvation terminate the case before distant metastases have time to form.

STOMACH.—Number of cases, 208. Of this number 155 occurred in males and fifty-three in females, a ratio of three to one. The average age was fifty-six years, with an extreme variation of twenty-eight to ninety years. The pyloric end was involved in 80 per cent. of the cases, the cardia in 10 per cent., and the lesser and greater curvature in 10 per cent. When the cardia is involved the growth usually extends into the œsophagus, thus making it difficult to determine whether the growth arose primarily in the stomach or œsophagus. In this series there were but four cases of linitis plastica. It is of particular interest to note that thirty-two cases, or 15 per cent., showed no obvious evidence of metastases. The usual site of metastases is the lymph-nodes and liver, the latter organ being involved in 45 per cent. of the cases, and the lymph-nodes in 44 per cent. The lymph-nodes most usually invaded are, first, the suprapancreatic and retroperitoneal and, secondly, the gastric. The lungs were involved in only 6 per cent. of the cases. It may be said in general, that carcinoma of the stomach is either distinctly local or multiple local in growth.

SMALL INTESTINE.—Number of cases, three—males two, females one. The average age was fifty-five, the youngest being forty-one and the oldest seventy years. Two of these cases arose in the duodenum and one in the jejunum. The metastases were distinctly local in character, involving the immediately adjacent organs and lymph-nodes.

LARGE INTESTINE.—Number of cases, sixty-one. The average age is about the same as that for the stomach, namely, fifty-five years, with extreme variation of twenty to eighty-four years. Although the average age of fifty-five was about the same as that of the stomach, 33 per cent. of the cases occurred below fifty—a very much lower age average than that for carcinoma of the stomach. The sexes were more equally divided, being thirty-six males to twenty-five females, a striking difference to that of the stomach, in which the proportion was three males to one female. In the large intestine, the site most frequently involved was the sigmoid; next, the cæcum, then the descending colon with splenic flexure of the colon fourth. The transverse and ascending colon, excepting at the hepatic and splenic flexures, were seldom affected. Metastases usually were local in their distribution, involving the neighboring nodes and adjacent tissues. The liver, pancreas and spleen were seldom invaded, excepting where the primary growth originated in the near vicinity of these organs. Remote metastases to the pleural cavity were exceedingly uncommon, while the number of cases showing no obvious metastases was a strikingly common occurrence. It is of considerable interest to note that 25 per cent. of these autopsies showed that the primary cause of death was due to perforation and peritonitis. Metastases: local, forty-eight, multiple local, seven, diffuse, six.

RECTUM.—Number of cases, twenty-six—average age, fifty-six years; limits seventy-five to forty-four years. Sex: males, twenty-one, females,

five. In this site, carcinoma generally appears to be a far more widely metastasizing tumor than it is in any other position in the whole alimentary tract. It involves, in general, the neighboring nodes and adjacent tissues, the liver in 50 per cent. of the cases, and, not infrequently, other abdominal organs and the lungs. Metastases: local, eight, multiple local, four, diffuse, fourteen.

PHARYNX, LARYNX AND TRACHEA.—Number of cases, seven—average age, about fifty-two years; sex, all males. Metastases usually very local in their distribution, infiltrating the surrounding tissues and invading the neighboring nodes. Occasionally, these tumors invaded the lung and even the heart, but this seemed to be a rare occurrence. Ulceration with its subsequent infection seemed to be the most obvious cause of death. Metastases: local, five, multiple local, two.

LUNGS.—Number of cases, thirty-seven—average age, forty-nine, limits twenty-four to seventy-three years; sex, thirty-four males, three females. Three-quarters of these tumors were carcinomatous or adenocarcinomatous in type and arose probably in the bronchi. The remaining quarter were not gland-cell tumors, being more of the epitheliomatous or squamous type. The adenomatous tumors usually metastasized widely throughout the thoracic cavity, and in most cases involved many of the abdominal organs. The squamous-cell type of tumor was usually local in its growth, only one case metastasized distally to the kidney. Metastases: local, eight, multiple local, twenty-two, diffuse, seven.

BREAST.—Number of cases, fifty-one—average age, fifty-five, with extreme variations of twenty-one to eighty years; sex, one male, fifty females. This neoplasm in the latter stages of its course metastasizes extensively, locally and distantly. One of the interesting findings in this series was the more frequent involvement of the liver than the lungs, the former occurred in 34 per cent. of cases, while the latter in only 20 per cent. Bones, usually the ribs, were invaded in 22 per cent. of the cases; the involved ribs were probably local extensions. Occasionally these tumors widely disseminate themselves throughout the body, invading diffusely many organs and structures. Metastases: local, six, multiple local, thirty-three, diffuse, twelve.

OVARY.—Number of cases, six—average age sixty years, limits forty-three and seventy years. Metastases usually diffuse involving the surrounding structures, the retroperitoneal nodes, the liver and lungs. Metastases: local, one, diffuse, five.

CERVIX AND UTERUS.—Number of cases, twenty-two, of which sixteen occurred in the cervix and six in the body of the uterus. The average age was forty-five years, with limits of twenty-eight and sixty years. About 50 per cent. of cases occurred in women under forty-five. Metastases both cervix and uterus were usually local or multiple local, invading presumably by direct extension the bladder, surrounding tissues and regional lymphnodes. Only four cases involved distant organs, one of which arose in the cervix and three in the uterus. The one arising from the cervix metastasized

to the lungs, while of the three arising from the uterus, one metastasized to the pancreas, one to the pleura, lungs, liver and sacral vertebræ and one to the lungs. Metastases: local, thirteen, multiple local, five, diffuse, four.

PROSTATE.—Number of cases, forty—average age, between fifty-five and sixty years, with extreme variations of twenty-four to eighty years. About one-half the cases occurred in men of sixty years or over. These tumors usually showed extensive local involvement of bladder and regional nodes. The vertebræ was affected in about one-third of the cases, while extensive involvement of peritoneal and pleural cavities were the rule rather than the exception. Metastases: local, thirteen, multiple local, fourteen, diffuse, thirteen.

TESTICLE.—Number of cases, three. The number of cases in this series was so few that the age incident is of little, if any value. Average age was forty-four years, with thirty-eight years the youngest and fifty-five years the oldest. The metastases were mostly distant, involving extensively the lung, liver, the pleural and peritoneal cavities and occasionally the vertebræ. Metastases: diffuse, three.

URINARY BLADDER.—Number of cases, twenty-nine—average age, about fifty years, the youngest being thirty-eight, the oldest seventy-four years. Sex, twenty-seven males, and two females. This neoplasm in its growth shows a marked tendency to remain local, as over one-half the cases showed either no obvious evidence of metastases or else invaded only the immediately adjacent tissues. In less than one-half the cases the retroperitoneal nodes were involved, and distant metastases to lung, liver and bone were noted in but three cases. Metastases: local, sixteen, multiple local, ten, diffuse, three.

KIDNEY.—Number of cases, ten—average age fifty-five years, limits twenty-five to eighty. Sex, eight males, one female. Metastases almost invariably widespread, involving diffusely the abdominal and thoracic organs and lymph-nodes. The two cases of no metastases noted in the chart were probably adenomas. Metastases: local, three, diffuse, seven.

HYPERNEPHROMA.—Number of cases, thirty-two—average age, fifty-four, with the youngest eighteen, and the oldest seventy-one years. Sex, twenty-two males, five females. It is of interest to note that the average age for females was thirty-six years, while the average for males was fifty-five years. As a general rule, this is perhaps one of the most diffusely and profusely metastasizing tumors that we see, as it involves in most of the cases either the thorax or abdominal cavities or both, and in 20 per cent. of the cases bone. Metastases: local, four, multiple local, two, diffuse, twenty-six.

LIVER.—Number of cases, thirty-nine—average age, forty-six, limits eighty-five to twenty-four years. In a little less than half of the cases the age was forty-five years. Sex, thirty males, nine females. The growth in most cases seemed to be localized to the liver, but in 35 per cent., the tumor was a widely metastasizing one, extensively involving the lymph-nodes, peritoneum, many organs of the abdominal cavity, and rather infrequently the

lungs and pleura. Metastases: local, twenty-two, multiple local, three, diffuse, fourteen.

GALL-BLADDER AND BILE-DUCTS.—Number of cases, thirty-two. The average age incident is similar to that of the liver. The sex ratio was twenty-one males to eleven females. These tumors in about one-half the cases invaded the liver, evidently by direct extension. In other respects it metastasizes as does the primary carcinoma of the liver; that is, about twenty-one local and seven diffuse.

PANCREAS.—Number of cases, thirty-four—average age, fifty-six, limits seventy-five to thirty-three years. In only nine cases · out of thirty-four did it occur at ages under fifty. Sex, twenty-seven males, seven females. Metastases in the majority (60 per cent.) of cases invaded the liver and usually disseminated itself widely throughout the abdominal cavity, but only infrequently involved the lung (four times). Metastases: local, thirteen, multiple local, three, diffuse, eighteen.

THYROID.—Number of cases, five—average age, forty-four years, limits thirty-five to sixty years. Sex, three males, 2 females. One of these tumors was of local growth, four extensively involved the liver and lungs and supraclavicular nodes. Metastases: local, one, diffuse, three.

PAROTID.—Number of cases, three—average age, fifty-two years; all occurred in males. The two that metastasized were remarkable, in that their metastases were widely distributed throughout the body, involving almost all the organs and structures of the thoracic cavity, the liver in one case and the adrenals and kidneys in both. The one case that did not metastasize was evidently the local growing, non-metastasizing type of mixed tumor. Metastases: local, one, diffuse, two.

BRANCHIOGENIC.—Number of cases, three—average age, fifty-five, with the youngest forty-four and the oldest seventy years. Sex, two males, one female. In one of the cases the neoplasm remained of local growth, involving extensively the tissues of the neck. The remaining two cases involved not only the structures of the neck, but metastasized distantly to the liver. Metastases: local, one, diffuse, two.

THYMUS.—Number of cases, one—age five; sex, male. In this case the tumor metastasized to the neighboring nodes, lung and pleura. Metastases: diffuse, one.

SKIN.—Number of cases, seven, limits twenty-nine to sixty years, average age about fifty years. Sex, all males. Two of these cases arose from the skin of the neck, one on chest and one on leg, face, scrotum and penis. All of these tumors excepting two invaded the neighboring nodes alone. Of the two exceptions, one arose from the skin of the chest and metastasized to the lungs, the other arose in the neck and metastasized to the liver. Metastases: local, five, diffuse, two.

MELANOCARCINOMA.—Number of cases, nine—average age, forty years. Sex, all males. Two of these cases arose in the small intestine, two in the eye, four in the skin of the toe, leg and scapula. The origin of the other was

unknown. The outstanding characteristics of this tumor are its frequent widespread metastases. Few of the malignant tumors possess this power of growth; certainly there are none that exceed it. It is of interest to note that, regardless of its site of origin, the liver is frequently involved, while the lymph-glands, though usually invaded, sometimes seemed to be entirely free. Metastases: diffuse, nine.

PITUITARY.—Number of cases, one—age thirty-nine, sex, male. This neoplasm invaded locally the tissues, but did not metastasize.

TOOTH BUD (ADAMANTINOMA).—Number of cases, one—age fifty-five; sex, male. This tumor extensively invaded the tissues locally and involved the neighboring lymph-nodes.

CARCINOMA OF UNKNOWN ORIGIN.—Number of cases, twenty—average age, fifty-two years, limits thirty to seventy years. Sex, nine males, eleven females. Because of the diffuse nature of their growths, their site of origin was unknown. It is extraordinary the power of growth some of these tumors possess. One cannot help but be astounded by the remarkable powers of the living organism to withstand this onslaught for so long a time. Metastases: diffuse, twenty.

SARCOMATA

Sarcomata, unlike carcinomata, show no definite evidences in many cases of their site of origin, and are usually so diffusely distributed that their primary foci cannot with any degree of accuracy be determined. This is particularly true of lympho-sarcoma. Even in this series, some of these tumors seem to have involved, either primarily or secondarily, most organs and structures of the body. For this reason, it would seem advisable to present them in roughly classified groups, rather than to attempt a detailed description.

The average age was forty-five years, limits from three to seventy-four years. Twenty-five per cent. of the cases occurred at thirty-five or under. Sex, sixty-six males, twenty-nine females. Nearly half the cases (thirty-nine) were classified under the diagnosis of lympho-sarcoma. The average age for this group was forty-two years, with an extreme variation of from three to seventy-four years. Sex, twenty-eight males, eleven females. About two-thirds of the cases involved the lymph-glands, usually the retroperitoneal, seldom the cervical. In many cases, the lymph-glands were diffusely involved, while other organs and structures of the body were relatively free. The lungs and mediastinal nodes were seldom the primary site. The stomach was involved in but one case, the intestinal canal in seven, the liver in three and the thymus in six. The retroperitoneal region was diffusely invaded in nine cases. Metastases were usually very diffuse, tumors arising probably in the thymic and cervical region practically always invaded the mediastinum and not infrequently the retroperitoneal nodes, but, strangely enough, the lungs were often free. Tumors arising in the retroperitoneal region or retroperitoneal nodes, or in other structures in the abdominal cavity usually

TABLE I

Malignant Epithelial Tumors

Primary Site	Number	No Metastases	Nodes	Liver	Lung	Pleura	Pericardium and Heart	Spleen	Omentum	Mesentery	Peritoneum	Pancreas	Stomach	Small and Large Intestine	Uterus	Ovary	Adrenal	Kidney	Brain	Thyroid	Bone	Diaphragm	Skin	Thymus	Bladder	Trachea	Local	Multiple Local	Diffuse
1. Tongue	9	1	7	2	2	3	3	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	5	1	3
2. Œsophagus	83	29	34	19	14	0	1	1	0	0	2	2	4	1	0	0	1	4	1	3	2	1	0	0	0	0	49	25	9
3. Stomach	208	32	95	98	14	13	4	10	23	11	26	24	0	10	0	2	6	11	2	0	7	3	0	0	0	0	78	89	41
4. Small Intestine	3	0	2	2	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7	0
5. Large Intestine	61	36	16	14	0	1	1	1	1	1	3	2	0	0	0	0	2	1	0	0	0	1	0	0	0	0	48	4	6
6. Rectum	26	5	12	13	3	2	0	2	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	8	2	14
7. Pharynx and Larynx	7	4	3	0	1	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	5	12	0
8. Lungs	37	4	10	6	2	4	0	0	1	0	0	0	0	1	0	0	2	3	0	0	6	0	0	0	0	0	8	13	7
9. Ovary	51	5	21	17	10	8	0	4	0	0	3	2	0	1	0	0	5	2	3	0	12	0	0	0	0	0	6	0	12
10. Breast	6	0	3	7	2	0	0	0	0	1	2	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0	1	3	5
11. Cervix	16	8	8	4	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1
12. Uterus	6	1	4	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	3
13. Prostate	40	4	24	1	2	6	0	3	0	0	0	2	0	4	0	0	3	3	0	0	14	0	0	0	12	0	13	0	13
14. Testicle	3	3	1	0	15	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	10	3
15. Bladder	29	0	11	9	3	0	4	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	4	1	1	0	16	0	3
16. Kidney	10	17	4	1	3	2	3	3	1	0	0	0	0	0	0	0	3	0	0	0	4	0	0	0	0	0	0	2	7
17. Hypernephroma	32	2	13	3	8	3	1	0	0	0	0	0	1	1	0	0	0	1	4	2	6	2	0	0	0	0	3	3	26
18. Liver	39	4	5	2	6	2	2	1	0	1	2	2	2	0	0	0	3	4	0	0	2	0	0	0	0	1	4	2	14
19. Gall-bladder and Ducts	32	19	15	14	5	1	0	2	0	0	1	4	0	2	2	1	2	4	0	0	1	0	0	0	0	0	22	3	10
20. Pancreas	34	0	9	0	4	1	0	2	0	0	0	0	0	0	0	0	4	2	0	0	0	0	0	0	0	1	20	1	18
21. Thyroid	5	6	3	15	2	0	1	0	10	7	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	13	0	3
22. Parotid	3	1	2	21	1	0	0	0	1	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	2
23. Branchiogenic	1	1	0	2	0	0	0	0	0	1	0	0	0	0	0	0	2	2	6	0	0	0	0	0	0	0	1	0	1
24. Thymus	7	1	1	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	2
25. Skin	9	0	5	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	9
26. Melanoma	1	1	7	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0
27. Pituitary	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
28. Tooth Bud	1	1	1	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
29. Unknown	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20
Totals	770	187	314	254	115	48	21	30	37	28	43	43	8	22	2	3	36	38	18	5	56	9	8	1	13	1	320	216	234
Sarcoma	95
Grand Total	865

involved diffusely the lymph-glands and surrounding tissues, and not infrequently the liver and spleen. The mediastinal and bronchial nodes were invaded in less than one-half of the cases, while the lung appeared to be an infrequent site. Age in no way influenced the growth. The metastases at seventeen were not more extensive than were those of sixty.

TABLE II

Epithelial Tumors Arising from Skin and Mucous Membrane

Age	10–20	21–30	31–40	41–50	51–60	61–70	71–80	81–90
Skin		1	2	2	1			
Tongue				3	4	1		
Pharynx⎫ Larynx ⎬ Trachea⎭			1	1	5	1		
Lung		1	6	14	11	3		
Œsophagus			2	23	30	20	4	
Stomach		6	21	54	59	44	17	4
Intestine	1	4	6	10	15	19	5	2
Rectum			3	4	7	9	1	
Urinary Bladder			1	5	9	9	2	1
Gall-bladder			4	7	12	6	2	1
Cervix and Uterus		1	6	11	4			

Epithelial Tumors Arising in Glandular Organs

	10–20	21–30	31–40	41–50	51–60	61–70	71–80	81–90
Breast		2	2	15	11	5	3	
Prostate		1	4	5	10	9	10	1
Testicle			2		1			
Kidney		3	2	6	8	3	3	
Adrenal			1	3	1			
Pancreas			2	7	11	10	3	
Liver		2	10	6	5	10	4	

The breast was the primary site in two cases, both females. In one, the metastases widely involved the lymph-glands, in the other, besides the nodes, the lung, liver and rectum were invaded. It occurred in the prostate in one case. From the number of other structures involved, it would be difficult to state whether the tumor, at this site, was primary or secondary. Six of these tumors were thought to have originated in the lung, all occurred in males and at the average age of fifty years. Two-thirds of them extensively involved the lung, but did not invade other tissues. Of the remaining two, one metastasized to ribs and dura, the other to the kidney.

There were eleven primary tumors of bone, five of which occurred in the femur, three in the lower end of the tibia, two in sternum and ribs and one in the vertebræ. The average age was forty-four years and there were eight males to three females. Most of these tumors metastasized to the lung. A few were bizarre in their selection; for one from the ankle metastasized to the scalp, another from the femur to the heart, another from the sternum and ribs to the liver, while still another, an osteosarcoma of the right ankle, metastasized to the femoral glands.

Under the diagnosis of endothelioma of the dura were eleven cases. Their main interest lies in their benign character, for none of these tumors metastasized.

BRAIN.—Number of cases, e'ght—average age, twenty-seven, with extreme variations of from three to fifty-five years. Half of these cases occurred below twenty years, while three of this number were below ten. Sex, four males, four females. In five of the eight cases the condition was that of a glioma. Of the remaining three, two were spongioblastomas and one a neuroblastoma. All of these neoplasms were of local growth.

SPINAL CORD.—Number of cases, three—average age, forty-nine years. Sex, males two, females one. None of these tumors metastasized.

EYE.—Number of cases, one. It occurred in a male, aged four years. This neoplasm involved the optic nerve and metastasized distantly to the liver.

Comment.—In analyzing this series of cases, certain features present themselves as being of unusual interest. Briefly stated, they are as follows:

(1) The average age for all malignant tumors at autopsy was fifty-one. Men seem to be affected somewhat later in life than women. Tumors arising in the female organs of reproduction apparently occur at an earlier age than do those arising in other organs of the body. Malignant connective tissue tumors usually occur in the earlier decades of life, for the average age was forty-five years.

(2) The sex ratio of three males to one female would seem to be an exaggerated one, the probable explanation being that more males are autopsied than females. However, the ratio for œsophagus, stomach and intestines corresponds with the surgical ratio compiled from the combined records of the Presbyterian and French Hospitals, and from the First Surgical Division of Bellevue Hospital.

(3) The site of many of these tumors seems to a marked degree to be influenced by sex, as, for example, there are no necropsy records or surgical records on the First Division of an epithelioma arising from the mucous membrane of the mouth or tongue in a female. From the same records there are but two epitheliomas of the œsophagus occurring in women. In the stomach, the ratio is a little over three to one, while in carcinoma of the intestinal canal, the ratio is more nearly equal.

(4) Excepting in the very aged, age does not seem to influence metastases, for tumors occurring in those below thirty were not, as a general rule, more widely distributed than they were in those of fifty or sixty years. In the aged, the neoplasm was usually of local growth.

(5) In carcinoma of the stomach and intestines, the immediate cause of death in about 15 per cent. of the cases was perforation and peritonitis. It is interesting to note in this connection that, in the majority of these cases of the intestine, only definite symptoms were those of peritonitis.

(6) About 69 per cent. of the malignant epithelial tumors arising in, or from, the skin and mucous membrane remained local in their growth, invading either the neighboring lymph-glands and adjacent tissues or both, while

only 28 per cent. of the cases arising in glandular organs showed the same local tendency of growth.

(7) One of the very interesting findings in this review was the number of cases that showed only local invasion of the neighboring tissues and adjacent lymph-nodes. Perhaps, what is even of greater interest, are the cases in which the neighboring nodes were alone involved. This held true for carcinomata regardless of their site of origin, but were much more frequently found in the cases whose site of origin was the stomach, large intestine, urinary bladder and cervix.

(8) The most interesting feature of this series is the number of cases of supposedly malignant tumors that did not metastasize. Out of 770 morphologically malignant epithelial neoplasms, 187 showed no obvious evidences of metastases. In the stomach and large intestine, 15 per cent. of the cases were of local growth, this fact being particularly emphasized in many of the autopsy protocols. Any attempt to explain these findings would at least be speculative. Two, however, may be considered, as they seem to be supported by a certain amount of evidence: (a) the existence of two types of tumors, both of which show the same microscopic picture and react in a similar manner to the tissues in which they originate, but otherwise are dissimilar, for the course of one is that of a metastasizing tumor, while that of the other is local in its growth; (b) that all tumors of this type are potentially malignant, but their future course is guided and controlled by some factor or factors, which, for purposes of convenience, may be called resistance.

Perhaps the true explanation of why some malignant neoplasms diffusely metastasize and others do not may be entirely a matter of virulence and body resistance. To reason by analogy, from bacterial infections to malignancy, may not be tenable, but in any event both have enough in common to raise the question as to whether or not virulence and body resistance, are not the guiding factors in the growth of all malignant neoplasms, as they seem to be in all infections.

DESMOID TUMORS*

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In this report appears a brief analysis of the subject of desmoid tumors and particularly of those cases which occurred in The Mayo Clinic in the course of the years 1923 to 1929, inclusive. The cases were studied from the points of view of clinical and pathologic phenomena and of recurrence. Moreover, an analysis as regards recurrence is given of that part of the cases reported by Nichols, which occurred in the course of the years 1910 to 1922, inclusive.

Literature.—The medical literature contains a number of comprehensive studies of desmoid tumors. Especially to be recommended are those by Ledderhose, Pfeiffer, Stewart and Mouat, and Powers. Nichols' communication in its entirety was concerned with those cases which occurred in The Mayo Clinic from 1904 to 1922, inclusive.

Petresco and Noveleano reviewed, with their series, several very large tumors; the tumor reported by Gross and Stewart weighed six kilograms; that reported by Montgomery weighed nine kilograms; and one reported by Rokitansky weighed seventeen kilograms. Petresco and Noveleano described none larger than a "closed fist." Green reported a tumor arising from the fascia of the internal oblique and transversalis muscles, which measured twelve, six and ten centimetres in various diameters. Schuman reported, in 1924, the largest desmoid tumor in the recent literature. This tumor arose from the fascia of the rectus muscles and measured twenty, fifteen and twelve centimetres in various diameters. Stewart and Mouat reported, in their series, none larger than a "fetal head." The large tumor of Bodenstein measured twenty-four and twenty-seven centimetres in different diameters. Bouffleur reported a very large tumor, which frequently is referred to, and incorrectly so, for the author himself called this tumor a fibrosarcoma and not a desmoid tumor. It was a rapidly growing, large, vascular tumor of the lower part of the abdomen and pelvis, and had none of the characteristics which have become assigned to the group of desmoid tumors. The report of Nichols did not contain reference to large tumors.

Presumably due to the campaign of education of the public conducted by the medical profession, the very large desmoid tumor of the earlier literature has disappeared, since aid is sought by the patient soon after the tumor is discovered.

With regard to recurrence, the largest series was studied by Pfeiffer. He reviewed 107 post-operative cases and found recurrences in thirty-three

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(30.8 per cent.). Of the 107 cases, eighty-five occurred among women, with relapse in eighteen; thirty-two occurred among men, with relapse in fifteen. Pfeiffer also stated that the smaller the growth and the more radical the excision the less the likelihood of recurrence. He called attention to the great difficulty of correct diagnosis of the larger tumors, an opinion which was expressed also by Stewart and Mouat and by Petresco and Noveleano, Stone, who reported a small series of cases, gave a very high proportion of recurrence: 90 per cent. among women and 68 per cent. among men. Stewart and Mouat did not report recurrence at the time of publication of their article, in their series of seven cases.

Etiology.—There was one case in the series observed in The Mayo Clinic in which direct trauma to the biceps muscle of the left arm appeared to be related to the appearance of a desmoid tumor. With this exception, nothing can be added to what has been published elsewhere as regards etiology, although it might be noted that in three instances desmoid tumors of the abdominal wall were found in scars that followed operative procedures.

Symptoms.—This type of tumor seldom has caused symptoms, other than by reason of its presence as a foreign body, or of its size. The tumor, in most instances, is found by the patient, and may be carried for a number of months or years before it is brought to the attention of a physician. Certain of the tumors have been found in the course of a general examination and have been symptomless. The symptoms which cause medical aid to be sought are usually (1) mild sticking pain; (2) sudden increase in size of the tumor; (3) a dragging sensation from weight when the tumor is large; and (4) occasionally the presence of the tumor in such a situation that it interferes with function in one way or another. In the case of a nervous patient the presence of the tumor is a source of many bizarre symptoms.

Diagnosis.—If diagnosis of this type of tumor is to be made, the possibility of its presence must be continuously borne in mind since it is very rare. The fifty cases that form the basis of this report were gathered from a series of patients observed at The Mayo Clinic in the course of the years 1910 to 1929, inclusive.

Desmoid tumors are more frequently found in the abdominal wall than elsewhere, and first of all must be distinguished from malignant tumors. Then there are many benign conditions for which desmoid tumors must not be mistaken, but in this respect confusion usually is easily avoided. Such conditions are large single stone, hydrops or empyema of the gall-bladder, omental tumors, ovarian and other cysts, salpingitis, hematomas of the abdominal wall, appendiceal abscesses, tumors of the pelvis such as osteomas and chrondromas, retroperitoneal tumors, and hernias in one situation or another. The history and general examination together with certain laboratory adjuncts usually will allow distinction between most of them. Desmoid tumors situated in other parts of the body than the abdominal wall present less diagnostic difficulty.

Prognosis.—This condition, by itself, never has been known to cause death. Once a correct diagnosis has been made the tumor can safely be removed and cure will result. Even if differential diagnosis cannot be made, biopsy can be obtained under local anæsthesia, and by the rapid frozen section method developed by Wilson and MacCarty the true nature of the neoplasm can be revealed.

Ewing expressed the belief that the more cellular the structure of the tumor, the greater is the likelihood of recurrence. However, it seems more likely that failure completely to remove the bands of tissue which infiltrate the adjacent muscle is the cause of recurrence of desmoid tumors.

Pathology.—The term desmoid tumor is used at The Mayo Clinic to designate benign fibroma arising from musculo-aponeurotic structures, not only of the abdominal muscles but also of other parts of the body. Since

Fig 1 —The bandlike arrangement of the tissue in desmoid tumors

by definition the tumor is benign, the desmoid tumor which contained sarcoma, reported by Donald and Caylor, is not considered in this report, except as a caution that careful histologic and gross study be made of all desmoid tumors.

There are excellent descriptions of this tumor, both gross (Fig. 1) and histologic, in the reports in the literature. The tumor is discrete, very firm, as a rule movable, rounded, of variable size, and may be situated subcutaneously or on the posterior surface of a muscle. In some cases muscle may be palpated over the tumor. The freshly removed tumor is seen to arise from the muscularis aponeurosis; it is pinkish-white, cuts with difficulty and the knife creaks as it proceeds through the tissue. Ewing pointed out that the cut surface resembles neurofibroma, owing to the intertwining bands of connective tissue. Indeed, it was this characteristic which led Johannes Muller to name the tumor desmoid. The larger tumors often give evidence

of central softening, and the history elicited is of rapid enlargement and consequent apprehension as to possible malignant change. The enlargement is due, however, to interference with blood supply and consequent œdema and mucoid degeneration, as was early pointed out by Labbe and Remey.

Histologically, these tumors resemble, at first glance, fibrosarcomas of low grade; however, careful study will show them to be composed of fibres and bands of adult fibrous connective tissue, with nuclei varying in size according to the age of the cell. There never are present nuclei containing large amounts of darkly staining chromatin, nor large multiple nucleoli, both of which are indications of rapid proliferations. There is no capsule or definite line of cleavage between the tumor and the adjacent muscle. In fact, it seems that the tumor begins from a nidus in the aponeurosis, and that the portion adjacent to the muscle begins to infiltrate the muscle fibrils, without causing any tissue reactions (Fig. 1), whereas the opposite side of the tumor grows much larger. There are few hindering structures in this

FIG. 2.—Recurrent desmoid tumor. The tumor tissue has infiltrated between muscle fibres (×150).

FIG. 3.—Infiltration of a desmoid tumor between muscle fibres. The tumor was removed surgically and did not recur (×115).

direction. That the tumor grows slowly is shown by the presence throughout of normal adult blood-vessels in a high percentage of cases.

Failure completely to remove the tumor surgically will leave strands of interfibrillar desmoid tissue and the tumor will recur. In the literature, or in the series of cases recorded at the clinic, metastasis in regional lymph-nodes or distant metastasis never has been noted. The recurrent tumor is situated at the site of the primary growth. The degree of muscular infiltration does not seem to be of importance; it is about equal in recurrent cases and in cases in which cure has followed operation (Figs. 2 and 3).

Treatment.—The methods of treatment employed by the surgeons at The Mayo Clinic have not varied greatly in the period of twenty years covered by this report.

The growth is removed as widely as the physical conditions will permit. and such portions of the growth as must be allowed to remain are submitted to treatment by radium or deep Röntgen-rays. This procedure is used in

cases of the larger tumors and in cases of tumors which are smaller and have recurred. Many of the smaller tumors may be successfully treated by simple wide excision. The results reported here recommend treatment by radium and Röntgen-rays as an adjuvant to surgical excision, for the use of radium or Röntgen-rays, without operation, has not met with complete success.

Of the cases observed at The Mayo Clinic between 1910 and 1929, inclusive, there were three in which, due to the situation of the tumor, to likelihood of ventral hernia, or to the size of the tumor, only partial excision was done and treatment by radium and Röntgen-rays was instituted. At the time of writing this paper, desmoid tumors had recurred in all of these three cases. In a fourth case, which was included in that part of Nichols' report which we have utilized, an operation was done for desmoid tumor of the abdominal wall. The patient returned one year later. A tumor had not recurred at the site of the primary operation, but the patient did have an independent desmoid tumor at the orifice that had been made at a previous ileocolostomy and another independent desmoid tumor just above the symphysis pubis. These later, independent tumors were unsuccessfully treated by Röntgen-rays and radium.

ANALYSIS OF CASES

Situation of tumors: age and sex and patients.—At The Mayo Clinic, in the course of the years 1923 to 1929, inclusive, treatment for desmoid tumor was instituted in twenty-seven cases. In eighteen cases the tumor arose from the abdominal wall. Fourteen of the patients were women, of whom ten had been pregnant one or more times previous to the appearance of the growth. Ten of the fourteen patients were aged from twenty to forty years. The four male patients were between the ages of twenty and sixty years.

In nine cases there were desmoid tumors elsewhere than in the abdominal wall: two in the muscles of the thoracic wall; one in the sternomastoid muscle; one in the biceps muscle of the left arm; one in the scapular region; one in the left extensor carpi ulnaris muscle; one in the left rectus femoris muscle; one in the group of muscles which combine to form the tendons bounding the left popliteal space, and one in the right masseter muscle. There were five men and four women in this group.

The cases reported by Nichols which occurred in the course of the years 1910 to 1922, inclusive, involved twenty-two cases in which there was one tumor each and one case, which has been mentioned in the section on treatment, in which there was one initial tumor and, later, two independent tumors. In twenty-one of these twenty-three cases, including the case of multiple tumors, the growths were in the abdominal wall; in two cases the growths were in other regions.

Recurrence.—Questionnaires were sent to the patients. By replies to

TABLE I

Desmoid Tumors of the Abdominal Wall Seen at The Mayo Clinic, 1923 to 1929, Inclusive

Case	Age, years, and sex	Preg-nan-cies	Position and origin of tumor	Size, centimetres and weight, grams	Duration before treatment, months	Treatment	Date of operation*	Recurrence
1	20 F	1	Right lower quadrant of abdomen	10 by 9 by 6 264	9	Surgery and radium	April 7, 1927	No reply
2	28 M		Upper right rectus muscle	3 by 2	23 years	Surgery	August 7, 1924	None February 27, 1930
3	28 F		Left internal muscle	7 by 6 by 4	10	Surgery	October 29, 1923	No reply
4	23 F	2	Left internal oblique muscle	2.5 by 2	?	Surgery	January 29, 1926	None February 19, 1930
5	36 F	3	Scar in right rectus muscle	6.5 by 9.5	2 or 3	Surgery and radium	March 23, 1928	2.5 by 3.75 centimetres; 6 radium treatments
6	39 F	3	Scar in left rectus muscle	10 by 9 by 7	2	Surgery	October 25, 1926	Noted December, 1926; removed elsewhere January 22, 1928; none since
7	35 F	2	Right rectus muscle	7 by 7	12	Surgery	September 4, 1929	No reply
8	25 F	1	Internal oblique mus-cle	3.5 by 3.5	2	Surgery	March 31, 1928	None February 10, 1930
9	26 F	1	Right internal oblique muscle	5 by 4 by 3	12	Surgery	March 11, 1924	None March 6, 1930
10	34 F	5	Right internal oblique muscle	4.5 by 2 by 2	15 years	Surgery	March 21, 1924	No reply
11	2 F		Left rectus muscle	5 by 5	12	Surgery and radium	October 25, 1927	In scar 1 year after operation 3.75 by 6.75 centimetres at present time

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TABLE I—(Continued)

Case	Age, years, and sex	Pregnancies	Position and origin of tumor	Size, centimetres and weight, grams	Duration before treatment, months	Treatment	Date of operation*	Recurrence
12	50 F	1	Scar in abdominal muscles	3.5 by 3.5	24	Surgery and radium	August 17, 1928	November 4, 1929
13	49 F		Right iliac region	12 by 6 by 5 150	7	Surgery and radium	July 13, 1928	None February 25, 1930; hernia present
14	24 F	1	Right internal oblique muscle	4 by 3 by 3	5	Surgery	September 11, 1928	No reply
15	35 F		Right iliac region	95	2	Radium and surgery	July 4, 1929	Very little remained March 8, 1930
16**	32 M		Left lower quadrant	17 by 8 by 4 8.5 by 7 890	36	Surgery and radium	December 23, 1929	Small amount remained April 2, 1930
17	54 M		Right rectus muscle	7 by 3 by 1	21	Surgery	November 12, 1924	Died November 17, 1924; sepsis
18	67 M		Left internal oblique muscle	4.5 by 4 by 3	6	Surgery	January 18, 1924	None February 25, 1930

* Immediate post-operative condition of patient good in all cases except case 17.
** This is the largest tumor removed in The Mayo Clinic series, 1904 to 1929, inclusive.

Desmoid Tumors Situated Elsewhere Than the Abdominal Wall, Seen at The Mayo Clinic, 1923 to 1929, Inclusive

TABLE II

Case	Age, years, and sex	Pregnancies	Position and origin of tumor	Size, centimetres	Duration before treatment, months	Treatment	Date of operation*	Recurrence
19	60 M		Left pectoralis major muscle	6.25 by 7.5	2	Surgery and radium	May 8, 1927	None February 27, 1930
20	4 M		Left sternocleidomastoid muscle	3 by 3	2.5 years	Surgery and radium	July 11, 1929	None March 3, 1930
21	12 F		Left ham strings	10 by 10	12	Surgery and radium	October 6, 1925	None March 15, 1926
22	24 F	2	Left extensor ulnaris carpi muscle	9 by 5 by 4	24 years	Surgery	April 22, 1929	None March 10, 1930
23	60 M		Rectus femoris muscle	2 by 2	3	Surgery	October 18, 1928	None April 2, 1930
24	40 F	2	Right side of thorax	3.5 by 2.5 by 2	4 years	Surgery	July 21, 1928	None April
25	38 M		Right masseter muscle	3 by 1.5 by 2.5	2	Surgery	November 3, 1928	None February 25, 1930
26	47 M		Right scapular region	5.5 by 2.5 by 1.5	6 or 7 years	Surgery	June 16, 1928	None February 24, 1930
27	32 F	3	Trauma; left biceps of arm	8 by 6 by 3	9	Surgery	June 4, 1924	July 20, 1928; removed elsewhere

* Immediate post-operative condition of patient good in all cases.

these inquiries or by other means, data concerning recurrence were obtained relative to thirty-nine of the fifty patients.

As has been pointed out, abdominal desmoid tumors were removed in eighteen cases between 1923 and 1929, inclusive. In one case the patient died from sepsis five days after operation and the case cannot, therefore, be included in estimations concerning recurrence. Excluding this case, data concerning recurrence were available by questionnaire or otherwise in twelve cases. The failure of irradiation to prevent recurrence in three cases has been related in the section on treatment. In nine other cases of this group of twelve, surgical operation was the major procedure and, in some, incidental treatment by Röntgen-ray or radium was given. Recurrence was reported in three cases; two of the patients were women of child-bearing age who had had one or more pregnancies, and the third patient was a child aged two years. In all of the nine cases in which desmoid tumors occurred in situations other than the abdominal wall, follow-up data were obtained; in one case recurrence was reported.

Of the twenty-one cases in Nichols' series, in which there were abdominal tumors, data concerning recurrence were available in seventeen. Recurrence had not taken place in any case of this group. In two cases in which desmoid tumors had occurred in regions other than the abdominal wall, it was learned that recurrence had not taken place.

SUMMARY

At The Mayo Clinic, in the course of the years 1910 to 1929, inclusive, fifty patients with desmoid tumors were seen.

Thirty-nine, or 78 per cent., of the fifty patients either answered questionnaires concerning recurrence of the tumor or else the desired information was available otherwise.

Among the cases in which the tumor was in the abdominal wall, data concerning recurrence were available in twenty-nine.

In ten cases in which a desmoid tumor was situated elsewhere than in the abdominal wall, a reply to the questionnaire was received. Recurrence was reported in one case.

In three cases in which treatment was mainly or entirely by radium or Röntgen-rays, recurrence took place, and in a fourth case the treatment was unsuccessful otherwise.

In thirty-five cases surgical operation was either the only method of treatment applied or was the principal method. Recurrence is known to have taken place in four cases.

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HERNIA OF THE UMBILICAL CORD (EXOMPHALOS)

By Alec Horwitz, M.D.

OF WASHINGTON, D. C.

The rarity of umbilical cord hernia justifies the following report:

A male child, referred by Doctors Kotz and Eanet, presented a globular mass about ten centimetres in diameter, at the umbilicus. The mass, which extended into the umbilical cord, contained intestinal coils which could be seen through the thin covering of "Wharton's jelly." The child, only a half-hour old, cried lustily and showed no other congenital defects. The hernial opening was about four centimetres in diameter. By lifting the abdominal wall on either side, the contents of the hernia were reduced but recurred immediately on the release of the abdomen. Without any anæsthetic a purse-string suture of chromic catgut was placed in the skin about a half centimetre from the junction of skin and cord, care being taken not to enter the peritoneal cavity. The hernia was now reduced again and the purse-string suture tied firmly. The excess cord was cut away and a flat piece of metal, about five centimetres in diameter, covered with gauze, was placed over the umbilicus and the abdomen was strapped tightly with adhesive.

Except for an inanition fever which was present for several days and which disappeared after the addition of artificial feedings, the convalescence was uneventful. The child was circumcised on the eighth day and dismissed from the hospital on the fourteenth day. The abdomen was still protected with an adhesive tape binder.

Hernia of the umbilical cord is an extremely rare condition. Lindfors gives the incidence as one in 5,184 births, Balantyne 1 in 5000, Watson 1 in 10,000. Only four cases of hernia of the umbilical cord were met with in over 75,000 cases of hernia in the Hospital for Ruptured and Crippled in eighteen years. Hebert (1928) gives figures from a number of hospitals which corroborate more or less the above figures.

Etiology.—The cause of umbilical cord hernia is a developmental defect. The underlying cause is still a moot question. It is, of course, known that from the fourth week to the tenth week of embryonic life there is present a physiological umbilical cord hernia. When the primitive gut is differentiated into recognizable regions, the intestinal region forms a simple tube of uniform diameter, extending from the stomach to the caudal end of the embryo, where it ends blindly. As the stomach changes its position the rest of the intestine forms a loop which extends ventrally and caudally as far as the umbilicus. The arms of the loop are almost parallel and are placed one cephalic and one caudal. The apex of the loop extends into the umbilical celom and is attached to the yolk stalk. Very shortly after the formation of the long loop in the intestine six bends become recognizable in the cephalic arm of the loop between the stomach and the apex. These bends form distinct loops which are destined to become the small intestine. The first loop is the duodenum which is fixed *within* the abdomen, but the other loops continue to elongate and form secondary loops. All of these push their

way into the *umbilical celom* until the embryo reaches a length of 40 millimetres.

Some think that the enlargement of the liver at this time pushes the intestine out into the umbilical celom and when it decreases the intestine returns. Others believe that reposition takes place because of the pull on the omphalomesenteric vessels when the liver grows caudally towards the pelvic cavity. As to why this physiological hernia persists there are many views. Ahlfred claims it is due to incomplete closure and constant pull of the vitelline duct. Sievers mentions many other theories only to show that they have been made to conform to a certain case presented. Scheffzek reports a case which he thinks was caused by a fetal peritonitis during the second month of embryonic development and that the adhesions formed caused the persistence of the hernia. Aschoff mentions as a possibility the persistence for a longer time than usual of the dorsal concavity of the vertebral column which in turn causes a decrease in the size of the abdominal celom. This forces the intestine to develop in the umbilical celom and causes a persistence of the hernia. Cummins, in discussing Hebert's three cases, divides the types of exomphalos into two grades: (1) small herniæ, due to persistence of the physiological hernia; (2) larger herniæ, due to lack of closure of the somatopleure and amnion which progressively grow toward the yolk stalk to form the anterior abdominal wall. He states further that it is accepted by modern embryologists that any maldevelopment may arise through the action of a single causative factor. Selectivity depends on the embryonic period the influence is brought to bear. In umbilical cord hernia he would seek the cause in endometrial pathology, maternal toxæmias, and similar causes. Sievers explains that a single defect may start a train of other defects because of a correlative development of other organs which are dependent on the process first disturbed. As an example is his case of an umbilical hernia which was complicated by a diaphragmatic hernia and a partial situs inversus. And so we find other cases reported which are accompanied by other congenital defects such as a patent Meckel's diverticulum, ectopia vesicæ, or other intestinal, hepatic or genital defects.

The coverings.—The coverings of the hernia are (1) a thin membrane continuous with the parietal peritoneum (called by Cannon Rathke's membrane); (2) "Wharton's jelly;" and (3) the thin amniotic layer covering the cord. Cannon objects to the term hernia but calls it an exomphalos.

Diagnosis.—The diagnosis is fairly easy if the hernia is large, but the condition should be kept in mind because a small knuckle of intestine could easily be tied off with the cord.

Prognosis.—In small herniæ the prognosis is good. In larger herniæ the prognosis is dependent on the time that has intervened between birth and operation. The earlier the operation the better the prognosis. Certainly complications such as strangulation, incarceration or the complicating defects lower the chances for recovery. Non-operated herniæ showed a mortality of 75 per cent. according to McDonald, who reported twelve cases.

Treatment.—Small herniæ can be treated by bandage compression. Large herniæ should be treated by extraperitoneal operation, incising the skin if necessary to allow closure of the hernial opening. If absolutely necessary because of the irreducibility of the hernia or because of strangulation, intraperitoneal operations can be done, care being taken not to overlap too much in the repair of the abdominal wall. Anæsthetics used varied from chloroform and ether, to local anæsthesia. In some cases, as in the one reported,

no anæsthesia whatever was used. Sievers advocates avertin with addition of ¼ per cent. novocaine with adrenalin locally, if necessary. It would seem advisable to operate on these cases immediately after they are recognized, if operative intervention is indicated; for if delayed, the amnion and peritoneum become glued together and the operation is then much more hazardous.

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TRANSACTIONS

NEW YORK SURGICAL SOCIETY

STATED MEETING HELD APRIL 23, 1930

The Vice-President, DR. JOHN DOUGLAS, in the Chair

ACUTE DEFERENTITIS WITH ABSCESS FORMATION

DR. RALPH COLP presented a man, aged forty-one, who was admitted to the Surgical Service of Doctor Lewisohn, Mt. Sinai Hospital, November 14, 1929.

At the age of twelve, he had a swelling of the left leg which lasted for five years. Eight years ago he had a chill lasting for two hours, associated with scrotal swelling and redness. The œdema of the scrotum lasted one week. Four years ago he had a chill lasting two hours, associated with chylemia, the latter persisting about two months. For the past twenty years he has had a left inguinal hernia. Nine days before admission, the inguinal mass became seemingly irreducible and tender, and the patient vomited several times.

The physical examination at time of admission was practically negative except for the local surgical condition in the inguinal region. From the region of the external ring to the scrotum, a hard, firm mass, slightly tender, presented itself. The mass extended into the scrotum displacing the testicle which felt normal. The mass did not transilluminate. No impulse was felt on coughing; prostate normal; temperature and pulse normal; urine examination and blood count normal.

Under local anæsthesia, an inguinal incision was made. The aponeurosis of the external oblique was incised in the direction of the fibres. The spermatic cord was found markedly thickened and very œdematous. Aspiration of the cord revealed a thick, odorless, yellow pus. The cord was incised and the pus evacuated. The vas was thickened to four times its normal diameter, the veins were not thrombosed. The abscess cavity was packed with iodoform gauze and the wound was partially closed.

The Wassermann was negative and several examinations of the blood failed to disclose the presence of filaria. Tissue removed from the abscess showed infected granulations. The bacteriology of the pus was streptococcus hemolytic beta.

Patient made an uneventful recovery following the operation.

DR. COLP presented a second man, aged fifty-nine, who was admitted to the Surgical Service of the Beekman Street Hospital, January 11, 1929, complaining of a difficult urination which dated back over eight years. He has to be catheterized very often because of a stricture of his urethra, following a Neisserian infection contracted twenty years ago. He states that he has had severe shaking chills at intervals of about six months for the past seven or eight years but he believed that this usually followed a catheterization. Two days before admission he complained of a tender mass in the right groin which seemed to appear quite suddenly. He had no gastro-intestinal symptoms and no preceding hernia.

Examination disclosed in the right inguinal region a mass the size of a tangerine orange. This mass was tender and immovable and no impulse was

elicited on coughing. The scrotum and its contents felt normal. The rectal examination was negative. The temperature and pulse were normal. The urine examination disclosed pus and albumin. The blood count was normal.

Under spinal anæsthesia, an inguinal incision was made on the right side. The aponeurosis of the external oblique was incised. The spermatic cord was found to be thickened and œdematous. In mobilizing the cord, a definite abscess containing about a dram of foul-smelling pus was encountered. This apparently arose from a definite visible perforation in the vas which was markedly thickened and irregular. The wound was packed with iodoform gauze.

Following operation, patient ran a temperature between 110° and 102° for three days. The blood count was normal. Then on the fourth, fifth and sixth days he had a severe shaking chill with temperature of 105°. Examination of the blood smears showed the parasites of tertian malaria. From the type of daily chill, evidently a double tertian infection was present. Following the administration of quinine, temperature returned to normal and he was finally discharged, the wound healing by secondary intention. At the present time the patient is well, although a large direct inguinal hernia is evident.

Cases of acute deferentitis and funiculitis are moderately rare, and may be subgrouped into three general varieties: acute gonorrhœal deferentitis and funiculitis, acute streptococcus funiculitis (known as the endemic variety, and invariably due to a thrombophlebitis of the veins of the pampiniform plexus) and those cases of funiculitis of indeterminate origin in which the pathology is obscure. The two cases now reported probably belong to this group. While in a series of thirty cases of funiculitis reported by Menocal the etiological factor was filaria, no present evidence of this condition could be found in Case No. 2, although the patient suffered from filariasis in the past.

Case No. 2 was probably caused by a focus in the posterior urethra reaching the cord either via the lymphatics or by retrograde peristalsis of the vas. While a deferentitis may involve simply the three coats of the vas, perforation may result as in Case No. 2 or the surrounding structures of the cord may be involved by contiguity resulting in a funiculitis. The treatment of these cases was simple. Following incision and drainage the condition rapidly subsided.

ANEURISM OF THE SUBCLAVIAN ARTERY

Dr. Ralph Colp presented a man, aged fifty-seven, who was first admitted to the Beekman Street Hospital on August 6, 1929.

The chief complaint was that of a throbbing mass on the right side of the neck. On February 18, 1929, he fell from a truck, injuring the right arm and shoulder. The region became very painful and swollen, and he received treatments of baking and massage for some time with fair results. About February 22, 1929, he noticed a mass about the size of a walnut just above the middle part of the right collor bone. The discovery of the mass was accidental and there was no discomfort in this region then. The mass continued to grow in size for the next four months and then the patient became conscious of a dull, throbbing sensation over the upper part of the right chest, most marked following physical exertion. Shortly after the accident, the arm, forearm and hand became swollen and painful; in fact, because of the swelling, the entire right upper extremity soon became almost useless.

The past history is practically irrelevant, lues being denied by name and

symptoms. The man was a well-developed negro. In the supra-clavicular region arising about three inches above the middle portion of the right clavicle was a mass the size of a lemon which pulsated and was expansile and through which the heart sounds could be heard. The anterior wall of the tumor seemed formed by the outer two-thirds of the clavicle. No mass or abdominal pulsation was felt in the axilla. The apex beat of the heart was felt in the fifth space outside the mid-clavicular line. There was dulness to the right of the sternum and dulness from the base to the mass. Apex beat was strong and regular and the heart sounds appeared normal.

The right upper extremity was swollen and tender and seemed to be about twice the size of the other arm. Motion was definitely restricted because of the œdema of the extremity. Left arm blood-pressure, 130/95, right arm blood-pressure, 120/70.

Under X-ray examination, at the root of the neck on the right side, lateral to the apex of the lung, there was a diffuse and considerable increase in density of the soft tissues as compared to the left side. This would be quite compatible with a subclavian aneurism. The process does not extend down into the chest.

Urine examination, negative; blood count, normal; Wasserman reaction, four plus.

The patient refused operation at this time but was subsequently readmitted on August 30, 1929, when it was decided to ligate the first portion of the subclavian artery for aneurism of the second portion of the artery. The operation was performed under gas, oxygen and ether anæsthesia. A four-inch incision was made over the clavicle from the junction of the middle and inner third to the sternal origin of the sternomastoid muscle, and then prolonged upward along the anterior margin of this muscle to the extent of three inches so as to make the letter "V." This, together with the underlying platysma, was dissected upward. The inner one-third of the clavicle was freed from its attachments and resected. The sternomastoid, the sternothyroid and sternohyoid muscles were then divided at their sternal attachments between clamps. The deep fascia of the neck was then divided and the internal jugular vein was dissected from its sheath and drawn laterally. The common carotid artery, together with the vagus nerve, was drawn mesially and the subclavian artery was identified and freed from the surrounding structures, care being taken not to damage the phrenic nerve. With an aneurism needle, a braided white silk ligature was placed about the first portion of the subclavian artery lateral to the common carotid and the artery was obliterated to about three-fourths of its diametre, three-eighths inch distal to this ligature on the aneurism side a chromic No. 4 ligature was tied around the artery tightly. Pulsations were seen to disappear immediately from the aneurism sac and it was seen to grow smaller. The aneurism sac itself was surrounded by dense fibrous tissue and no branches of the thyroid axis were apparent with the exception of the transverse cervical. The divided muscles were then united with interrupted plain catgut sutures, the deep fascia of the neck together with the platysma were closed with interrupted plain and the skin approximated with silk. Immediately following the operation, the condition of the patient was unusually good, although no pulsations could be felt in his radial or ulnar arteries.

On the first post-operative day there was less swelling of the right arm although the radial pulse was completely obliterated. Three weeks later the swelling and œdema of the arm were materially lessened and the patient was able to move his arm fairly well and was able to close his hand. The swelling

of the neck was about the same although there was no pulsation and it seemed firmer.

At present the patient is quite well. The supraclavicular mass is still present, although smaller, softer and without pulsation. There is practically no swelling of the extremity and all movements are almost normal. The radial pulse is present; the blood-pressure is 120 and the oscillometric reading is four millimeters as compared with a blood-pressure of 130/95, and an oscillometric reading of twelve millimeters of the normal left extremity.

Oscillometric Readings and Blood-pressures

	Right arm	*Left arm*
September 3, 1929.	Reading two millimetres B. P. 120. Hand swollen to about twice the normal size. Function markedly impaired.	9 B. P. 130/95
September 3, 1929.	Operation.	
September 4, 1929.	Reading three-quarter. B. P. of 100. Swelling of hand much less. Radial pulse obliterated.	—9
September 5, 1929.	Reading one-quarter. Hand colder. Swelling the same.	—9½
September 6, 1929.	Reading one-half millimetre. Hand warmer. Swelling the same. B. P. 100	—9 B. P. 120/90
September 7, 1929.	Reading one millimetre. Hand warmer. Function of fingers improved. Swelling decreasing.	—9½
September 9, 1929.	Reading one millimetre.	—9
September 11, 1929.	Reading three-quarter millimetre. Function of fingers improving.	—9
September 14, 1929.	Reading one millimetre. Function of fingers improving.	—9½
September 18, 1929.	Reading one millimetre. No radial pulse palpable.—9	
September 22, 1929.	Reading one millimetre. No radial pulse palpable.—9	
September 24, 1929.	Reading one millimetre. Very little limitation of motion of arm.	—9½
May 18, 1930.	Reading four millimetres, B/P 120. No limitation of motion of arm, forearm and hand, and practically no swelling.	—12 B. P. 130/90

This case is shown as a possible example of a traumatic aneurism engrafted upon a syphilitic basis. It is an aneurism of the second portion of the right subclavian artery, which is comparatively rare. While excisions of aneurismal sacs have been reported and endoaneurismorrhaphy results have been permanent, it was felt that simple ligation of the proximal portion of the artery was the operation of choice. This was, in itself, a comparatively simple procedure, especially following the technic outlined by Eliot in the ANNALS OF SURGERY, Volume LVI. p. 83. To have ligated the branches of the second portion of the vessel would have entailed much dissection, which probably would have resulted disastrously. Proximal ligation of the aneurism in this case certainly produced definite improvement in relieving the patient of a conscious throbbing and in reducing the œdema of the right upper extremity.

The supraclavicular mass is still present, although somewhat smaller. Whether a recurrence of this condition will take place a follow-up will tell.

DR. FRANK S. MATHEWS said that he once had a case of subclavian aneurism similar to Doctor Colp's, even to the plus four Wassermann. His patient had lived ten years after ligation of the vessel in comparatively good health. The operative procedure had consisted in dividing the clavicle, applying a distal catgut ligature and, as the proximal ligature had to be applied very close to the aneurism, making use of a fascial suture wrapped twice about the vessel.

ECHINOCOCCUS CYST OF THE LIVER

DR. RALPH COLP presented a man, a Maltese, aged thirty-eight, who was admitted to the Beekman Street Hospital December 16, 1927, and discharged
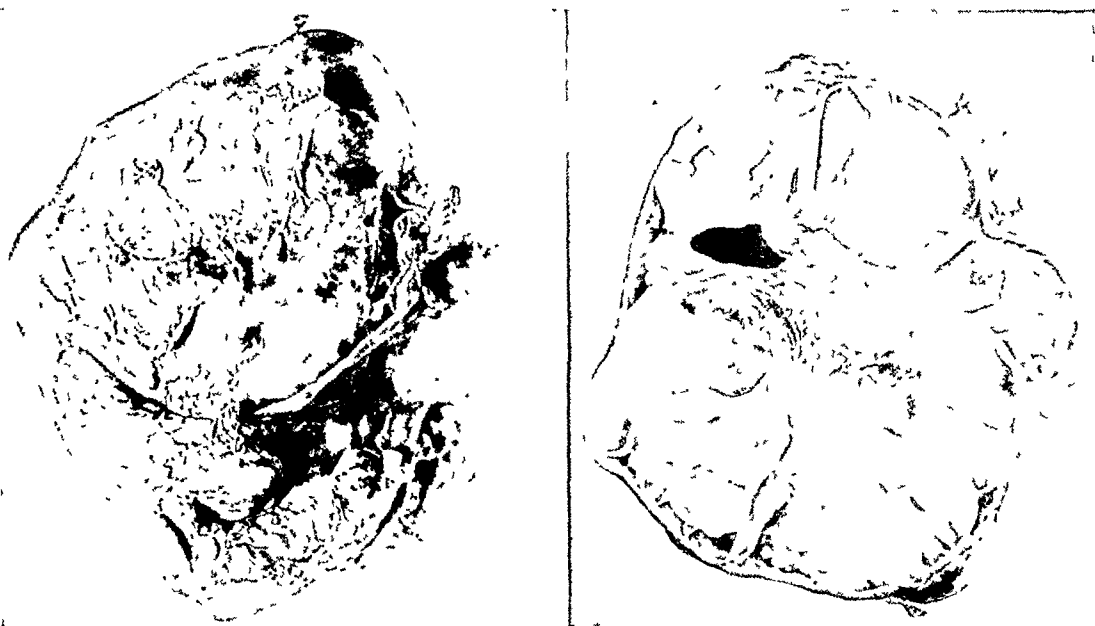
FIG. 1.—Echinococcus cyst of the liver.

December 21, 1927. His occupation was that of ship cook. He was readmitted March 28, 1928, for operation.

On the evening of his first admission, during a street brawl he was struck in the epigastrium; two hours later he vomited and fainted. An hour later he vomited again was brought by ambulance to the hospital suffering from pain and tenderness in the epigastrium.

He was a well-developed young white man, not appearing acutely ill. The abdomen was soft without rigidity, but tenderness was definitely present in the epigastrium. A mass was palpable occupying the epigastrium and extending into the left hypochrondrium. It was round, slightly irregular, seemingly cystic and not tender. It moved with respiration and was apparently attached to the liver. He stated that it had been there for about ten years.

X-ray examination of the abdomen revealed the presence of a cystic mass attached to or part of the right lobe of the liver, and, with the patient prone, it pressed out the duodenum, together with the pyloric antrum of the stomach, into the thin line. In the standing position there was no such deformity. The mass was definitely above the stomach and duodenum. (Fig. 1.) The stomach

and duodenum were empty in six hours, as well as all of the small intestines, excepting the terminal ileum.

X-ray of his chest showed no evidence of any echinococcus disease. The blood count was 7,100, with 78 per cent. polymorphonuclear leucocytes. No eosinophilia was present. Urine examination was normal, the Wassermann was negative.

He was advised to have an operation, and for this purpose was subsequently admitted March 28, 1928.

At operation a median incision was made reaching from the ensiform to the umbilicus. A large multilocular cyst mass (Fig. 1) was seen arising from the right lobe of the liver. This measured about ten inches in length with an average diameter of six inches. It was oval, irregular, lobulated and in some areas definite calcification seemed present. There was definite crackling in some of the cysts, but no thrill could be elicited. Adherent to the cyst wall in several areas were dense firm omental adhesions. There were no cysts to be seen or palpated elsewhere within the abdomen. The omental adhesions of the cysts were deligated, the right coronary ligament, the round ligament and the suspensory ligament of the liver were ligated and by this maneuver, the cyst was mobilized more freely. A line of demarcation was found between the cyst wall and the liver and the cyst was enucleated by blunt dissection. The under surface of the liver was packed with a Mikulicz tampon of iodoform and plain gauze. Two rubber drains were placed down toward the gastro-hepatic omentum.

Patient stood the operation itself unusually well. Within twenty-four hours, however, he began to vomit and abdominal distention became marked. However, with the administration of continuous intravenous 5 per cent. glucose and colon irrigations, this distention and vomiting disappeared, and seven days after operation his condition was excellent.

On the ninth day after operation while attempting to get out of bed, he disrupted his abdominal wound and several feet of small intestine protruded. Under chloroform anæsthesia, the intestines which had prolapsed into the wound were washed with saline and reposited into the abdomen and the wound closed with through and through silk sutures. Twenty days after operation all sutures and drainage were removed.

The patient was seen several months after operation, at which time he was well. Since then all attempts at follow-up have been unsuccessful.

Dr. Walter A. Sherwood asked if the history of this man had shown any association in his earlier life with sheep-herding dogs. A few years ago the speaker reported three cases with echinococcus cyst of the liver; one came from Sicily, one from Greece and the third from one of the Balkan States. Each of them had formerly lived in families where the principal occupation had been the raising of sheep and each had been in close contact with sheep-herding dogs, which is supposed to be the most common mode of infection with echinococcus hooklets.

Dr. Henry H. M. Lyle said that he had two of these cases and both came from Sicily, and both gave the history mentioned by Doctor Sherwood. One of the patients did well after the cyst was taken out; the other had a recurrence and is now under observation. The growth started with a lump in the groin like a hernia and was traced back to the liver.

THROMBOPHLEBITIC SPLENOMEGALY WITH GASTRIC HÆMORRHAGES

DR. RICHARD LEWISOHN presented a woman, forty years old, who was admitted to Mount Sinai Hospital January 23, 1929.

She had had two episodes of epistaxis, melæna, hematemesis and vaginal bleeding. The first attack occurred two years ago, the second six weeks ago. The bleeding lasted about three days. Examination revealed an enlarged spleen. There were no purpuric manifestations and there was no tendency to prolonged bleeding on cuts. Six weeks ago the patient had a recurrence of the bleeding and soon afterward her abdomen became distended. Two weeks before admission she had a paracentesis. Accompanying the ascites there was marked œdema of the face, hands and legs. Wassermann reaction was four plus. The patient has received two courses of antiluetic treatment in the dispensary of Mount Sinai Hospital, the last one in November, 1928.

Status.—The patient was very weak and markedly anæmic. Her pupils were irregular with poor reaction to light. Her spleen was of huge size, markedly enlarged and firm. The liver was not enlarged. Her blood picture (Doctor Rosenthal) showed the following: hæmoglobin, 30 per cent.; red blood cells, 3,100,000; white blood cells, 4,200; polymorphonuclears; 66 per cent.; lymphocytes, 30 per cent.; mononuclears, 4 per cent.; platelets, 200,000. The bleeding and coagulation time was normal. The Vandenbergh test gave: direct, negative; indirect, 1:500,000. The paracentesis (February 8) yielded 6,500 cubic centimetres of yellow fluid. Oxygen was injected for a pneumoperitoneum. X-ray examination showed an enormously enlarged spleen.

February 12.—The patient was given a blood transfusion, 500 cubic centimetres of blood being given by the Unger method, and the hæmoglobin rose to 40 per cent.

February 28.—The patient was given a second transfusion of blood, 750 cubic centimetres being given by the Unger method.

April 2.—Gradual improvement was noticed and there was no recurrence of the ascites. The hæmoglobin rose to 60 per cent.

May 2.—Splenectomy for thrombophlebitic splenomegaly under spinal anæsthesia. An eight-inch left subcostal incision exposed a very large spleen, markedly adherent to the diaphragm. The adhesions were divided and the pedicle was clamped. The abdominal wall was then sutured in layers without drainage. The specimen showed sinus hyperplasia and endophlebitis of the splenic veins.

The post-operative course was uneventful, except for a low-grade temperature which subsided spontaneously after two weeks. A test meal (May 30) showed achlorhydria. The patient was discharged June 18. She is now in excellent condition and has had no recurrence of hæmorrhage.

The last blood report (February 21, 1930, Doctor Rosenthal) was as follows: red blood cells, 4,500,000; white blood cells, 7,600; platelets, 320,000; lymphocytes, 45 per cent.; monocytes, 10 per cent.; polymorphonuclear eosinophiles, 2 per cent.; polymorphonuclear basophiles, 2 per cent. One of the interesting features of this case is the spontaneous disappearance of the ascites before the splenectomy. This phenomenon might possibly be explained by a tunneling of the previously occluded portal system. The patient has gained 20 pounds in weight since the operation; the hæmorrhages have not recurred.

DR. LEWISOHN presented also a young girl, seventeen years old, who was admitted to Mount Sinai Hospital March 24, 1928. Six weeks prior to admission the patient had a severe gastric hæmorrhage. During the next three days she had eight more hæmorrhages and was admitted to another hospital where

transfusion was performed. At that time she had a hæmoglobin of 25 per cent. and her red blood cells were 1,500,000. She stayed in that hospital for about one month, during which time her hæmoglobin rose to 45 per cent. and her red blood cells increased to 2,500,000. Her stool contained blood at times. One day before her admission to Mount Sinai Hospital she had three hæmorrhages. When admitted she was markedly exanguinated. Her blood examination (Doctor Rosenthal) showed: hæmoglobin, 30 per cent.; red blood cells, 2,500,000; white blood cells, 12,600; platelets, 260,000; polymorphonuclears, neutrophiles, 76 per cent.; eosinophiles, 2 per cent.; basophiles, 1 per cent.; myelocytes, 1 per cent.; lymphocytes, 10 per cent.; monocytes, 7 per cent. The fragility test revealed: partial hæmolysis, 0.48-0.32 per cent.; complete 0.30 to 0.26 per cent. She was given an immediate transfusion of 550 cubic centimetres of blood.

The patient ran a temperature between 101° and 104°. Her spleen and liver were palpable. A systolic murmur was heard at the apex. X-ray examination of the chest showed an enlarged heart. Wasserman reaction was negative. The Vandenbergh test showed: direct, negative; indirect, 1:125,000.

On discharge (May 26) the hæmoglobin was 41 per cent.; red blood cells, 1,370,000; white blood cells, 6,300; platelets, 260,000.

Readmission.—August 16, 1928; discharged January 17, 1929.

The day before her readmission the patient had a profuse hæmorrhage, and vomited five times thereafter. The liver was felt two and one-half fingerbreadths below the ribs. The spleen was not palpable. Her hæmoglobin was 38 per cent.; red blood cells were 3,800,000; white blood cells, 17,500; platelets, 340,000. The following day there was a recurrence of the vomiting.

August 18 she was given a blood transfusion of 425 cubic centimetres of blood (citrate method). Her spleen was now palpable, though it had not been palpable during the hæmorrhages. On September 3, the hæmoglobin had dropped to 27 per cent. She was given another transfusion of 450 cubic centimetres blood (citrate method) on September 4.

September 20.—Her condition was very much improved and the hæmoglobin had risen to 57 per cent. October 8.—another profuse hæmorrhage occurred and the patient vomited forty ounces of blood. The hæmoglobin fell to 35 per cent.

October 11.—Patient had another hæmorrhage, losing twenty ounces of blood. The hæmoglobin fell to 24 per cent. She was given a transfusion of 500 cubic centimetres of blood by the Unger method. October 16.—Another transfusion was given, (600 cubic centimetres) by the Unger method.

Diagnosis.—The medical service made the diagnosis of splenic vein thrombosis and suggested the possibility of ligating the splenic artery. Doctor Lewisohn stated that splenectomy seemed to offer the only chance for a cure in spite of the risk of a major surgical procedure for this debilitated patient.

November 18.—Tarry stools were noted. The hæmoglobin dropped to 16 per cent.

November 25.—The hæmoglobin fell from 60 per cent. to 24 per cent. and the patient was given another transfusion by the citrate method of 500 cubic centimetres of blood.

December 11.—The patient's hæmoglobin rose to 62 per cent.

December 13.—Splenectomy under spinal anæsthesia was carried out through a four-inch subcostal incision. The spleen was about three times normal size. The spleen was delivered, the pedicle was divided. No drainage was used. A small accessory spleen was left *in situ*. The specimen showed: phlebosclerosis of splenic vein; ramifications sinus hyperplasia; reticulum cell proliferation with giant cell formation.

Post-operative course.—The patient made an uneventful recovery except for a subcutaneous abscess. January 5, 1929, her hæmoglobin was 70 per cent.; platelets, 950,000; red blood cells, 4,200,000. She was discharged January 17, 1929.

April 24, 1929.—The patient's hæmoglobin is 79 per cent.; her condition is excellent.

April 18, 1930.—Blood examination shows a marked anæmia: hæmoglobin, 35 per cent.; red blood cells, 2,600,000; white blood cells, 11,200; platelets, 670,000. This patient is not cured, though the hæmorrhages have stopped.

DR. NATHAN ROSENTHAL (by invitation) said that thrombophlebitic splenomegaly belongs to a heterogenous group known as splenic anæmia or Banti's Disease, although in the latter condition gastric hæmorrhages occur as a late manifestation from cirrhosis of the liver. Twenty-three cases of splenic anæmia have so far been observed at the Mount Sinai Hospital. They can be further subdivided into well-defined groups:

1. *Cirrhosis of the liver with secondary splenomegaly.*—gastric hæmorrhages as a result of cirrhosis of the liver are due to portal obstruction.

2. *Thrombosis of the portal vein* especially in children secondary to infection of the umbilicus can also result in secondary splenomegaly. Gastric hæmorrhages may also occur.

3. *Thrombosis of the splenic vein.*—some of these cases may have gastric hæmorrhages, although in a few cases recently observed, hæmorrhages have been absent and the condition was found accidentally at autopsy.

4. *Thrombophlebitis of the splenic vein.*—Wallgren and others believe that the lesions in the splenic veins are responsible for most of the cases showing splenomegaly. Congestion in the gastric and œsophageal veins results from the obstruction in the splenic vein and is the main factor in causing hæmorrhages from the stomach.

5. A group in which the disease is primary in the spleen and all other manifestations may be considered secondary. This is the most important group under consideration and sometimes the changes of the blood picture were found to be very important in differentiating it from another group, especially before the operation. The blood picture shows a secondary anæmia and leucopenia and a marked diminution of the blood platelets. Such cases appear to be closely related to thrombocytopenic purpura, and splenectomy has proven favorable.

The second group, the thrombocythemic group, usually shows a similar blood picture except that the number of blood platelets are normal. Splenectomy has not been followed by good results. Thrombosis occurs after splenectomy and secondary anæmia may persist. These patients either succumb immediately after the operation, or within five days from thromboses in the portal vein and also other veins.

A pre-operative study of the first case presented by Doctor Lewisohn showed a definite etiological factor; namely, lues, and the blood picture before the operation showed a very marked thrombocytopenia. Thrombophlebitis was found by the pathologists, with secondary phlebosclerosis in the spleen.

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This does not fit into the groups mentioned above and shows the variations in the symptoms and causative relations of this particular condition. The second case possibly belongs to the thrombocythemic group, as the patient had a secondary hæmorrhage following the operation and the persistence of a thrombocythemia. It has been pointed out that the spleen in such cases may possibly be a secondary factor for the regulation of the blood platelets. Removal of this organ promotes the marked increase in the number of blood platelets, which is the cause of the secondary thromboses.

In conclusion, one must emphasize the variations of the blood picture, multiplicity of symptoms, the market variations and histological changes of the spleen and blood vessels, and the unusually high late mortality of cases in this group.

ECHINOCOCCUS CYST OF THE LIVER

DR. RICHARD LEWISOHN presented a man, thirty-three years old, who was admitted to the Medical Service of Mount Sinai Hospital May 17, 1926, and was discharged May 29, 1926. He had had an appendectomy in 1918 in another hospital. Three years before admission he experienced epigastric pain with sour eructations, lasting several weeks. There was no jaundice. He had been free of symptoms until four months ago, when the attack recurred. Two months later, he had another recurrence and collapsed on the street, following which he was taken to another hospital. He still complains of epigastric pain and distress after eating. He has a well-compensated mitral stenosis. X-ray examination failed to visualize the gall-bladder. The patient was discharged improved.

June 8, 1926.—The patient was readmitted to the Surgical Service of Mount Sinai Hospital, discharged June 29, 1926. X-ray examination gave the same findings: pathologic gall-bladder. On June 12 a cholecystectomy was performed by another surgeon. The gall-bladder was not enlarged, and the wall was not thickened. There were no stones. The common duct was not explored. There was a good deal of bleeding from the liver bed. The patient was given a transfusion of 500 cubic centimetres of citrated blood that evening. He made an uneventful operative recovery.

June 12, 1929.—The patient was again admitted to the Medical Service and discharged July 11, 1929. Several months after his discharge, the patient had recurrent attacks. Jaundice occurred with one attack. He entered another hospital where operation was advised. Physical examination showed percussion tenderness over liver. *Diagnosis.*—Common duct stone or postoperative stricture. He was re-operated upon by another surgeon under spinal anæsthesia July 1. The common duct was not dilated; no stones were found, the adhesions were divided.

July 20, 1929.—The patient was again admitted, and discharged July 21, 1929. Three days after his last discharge he had a recurrence of attacks. *Diagnosis.*—Cholangitis lenta; leucine and tyrosine negative. Eosinophiles I per cent.

December 9, 1929.—The patient was admitted again to the Medical Service, and was discharged December 16, 1929. Since his former discharge he had had two attacks with jaundice and clay-colored stools lasting one week. The eosinophiles were I per cent. He was given duodenal drainage and discharged after eleven days.

January 21, 1930.—The patient was readmitted, as the result of a violent attack of upper abdominal colic radiating to the right shoulder. Several hours

after admission icterus appeared and the urine contained bile. The liver function test showed a slight degree of liver damage. Eosinophiles 3 per cent. X-ray examination January 23 showed a large echinococcus cyst in the right lobe of the liver. (Fig. 2.)

Further X-rays with marking of the right costal arch and stereoscopic pictures showed that a transdiaphragmatic approach was preferable, as the cyst did not develop beyond the arch. For this reason, masurpialization did not seem possible. February 3 the first stage of the operation was performed. The tenth rib was resected under gas and oxygen anæsthesia. The pleura, which was like tissue paper, was inadvertently entered. The diaphragm was sutured to the opening in the pleura. The diaphragm was not adherent to the liver. The wound was packed. On February 10 the second stage of the operation was carried out and the eleventh rib was resected. The diaphragm was incised; a needle was introduced and turbid fluid was aspirated. Microscopic e x a m i n a t i o n showed typical echinococcus fluid. The cyst was entered and a large amount of pus, containing many daughter cysts, was evacuated. A large t u b e w a s introduced. The patient is still draining considerable amounts although the cyst has diminished in size.

This patient was admitted to different hospitals seven times and

FIG 2.—Echinococcus cyst of the liver.

was operated upon twice for suspected calculi, before the proper diagnosis of echinococcus cyst was established.

OPERATIVE STRICTURE OF THE COMMON DUCT, DUODENAL FISTULA

DR. RICHARD LEWISOHN presented a woman, fifty years old, who was admitted to Mount Sinai Hospital January 15, 1930. She entered the hospital with a temperature of 103.6°. She was deeply jaundiced and had the following history:

A cholecystectomy had been performed in April, 1927, at another hospital. This operation had been performed through a transverse incision and a large distended gall-bladder had been found. Cholecystectomy and appendectomy were performed. The surgeon who operated upon her stated that an extensive

hæmorrhage was encountered at the time of operation. He thought that he was dealing with an anomaly of one of the large vessels in this region. Two months after this operation she became markedly jaundiced and had chills and fever. These attacks recurred associated with epigastric pains about every three to four months and lasted about two to four weeks. Six days before her admission she had a similar attack with chills and high fever. This attack subsided during the first three days of her stay in this hospital and her jaundice cleared up.

The pre-operative diagnosis was stenosis of the common duct, probably due to traumatic injury. She was kept in this hospital about five weeks, during which time she gained seven pounds. There was some question as to the advisability of surgical intervention in view of the fact that her symptoms had subsided. However, the patient felt she could not be cured in any other way. A liver function test (Doctor Rosenthal) showed retention 35 per cent. and icterus index 30, indicating marked liver impairment.

Operation.—February 22, 1930. Under spinal anæsthesia between the first and second lumber vertebræ a six-inch Bevan incision was made. The peritoneum was easily entered. There were dense adhesions between the omentum and the abdominal wall at the site of the transverse incision. These adhesions were divided. It was very difficult to expose the common duct, as the duodenum was pulled up to the porta hepatis. The duodenum appeared markedly thickened. In freeing the duodenum the lumen of the gut was accidentally entered. This opening was closed in two layers. The part of the duodenum which was involved in this dissection appeared very hard, so much so that there was some doubt as to whether they were dealing with a primary ulcer of the duodenum. There was a large gland at the lower end of the common duct. After this dissection the common duct was well exposed, was not dilated and presented a thin wall. The common duct was entered and a probe was put up towards the liver. About one and one-half inches above the opening into the common duct, a thickened mass was felt, right at the porta hepatis. Whether this stricture was due to inflammatory reaction from without or to an injury of the common duct where it meets the hepatic duct could not be determined definitely. Though a fine probe went through this stricture, it was impossible to dilate it. The condition of the patient and the high location of this mass did not allow a hepatico-duodenostomy. A tube was put into the common duct leading up into the stricture. The opening in the common duct was closed. Two pieces of rubber dam were put around the tube and the wound was closed in layers.

The patient rallied very well from this operation under intravenous glucose infusion and drained well through the common duct. Two days after the operation there was a considerable discharge through the wound and carmine, given by mouth, appeared on the dressing. It was evident that they were dealing with a duodenal fistula. Chemical examination proved further the presence in the discharges of duodenal contents. An immediate jejunostomy (Witzel type) was performed under local anæsthesia and a catheter was introduced into the lower part of the previous operative field. This was connected with a suction apparatus (Fig. 3) and the skin was protected with zinc oxide ointment and talcum powder. Drainage into the suction apparatus was very profuse. She drained between twenty-eight and seventy-seven ounces per day. (Fig. 4.) The drained fluids were immediately reintroduced through the jejunostomy tube. The drainage stopped after two weeks (March 6). The bile, drained through the common duct tube, was reintroduced in the same way through the jejunostomy tube. The common duct tube was removed February 28. The jejunostomy tube was kept in place even after the duodenal

drainage had stopped, as the patient began to hiccough considerably. This hiccough sometimes lasted for twelve hours at a time and could not be controlled by CO_2 inhalations. The white blood cells were 26,000, polymorphonuclears 82 per cent. March 9 the patient began to vomit. As a subphrenic abscess was suspected the subphrenic space was aspirated with negative results. March 11 there was renewed vomiting. A stomach tube was passed and 16 ounces obtained. On the same day a citrate transfusion was given by the drop method through the glucose intravenous apparatus. March 14 her condition improved materially. She took forty-six ounces by mouth without vomiting or hiccough. Vandenbergh was normal. March 18 the jejunostomy tube was removed. The opening in the jejunum closed up immediately. There was no drainage from the site of the jejunostomy tube. From that time on her condition improved rapidly, and she left the hospital April 10, 1930.

It is generally agreed that a duodenal fistula is one of the most serious complications in abdominal surgery. In the attempt to save the life of the patient three problems have to be taken into consideration simultaneously: (1) the
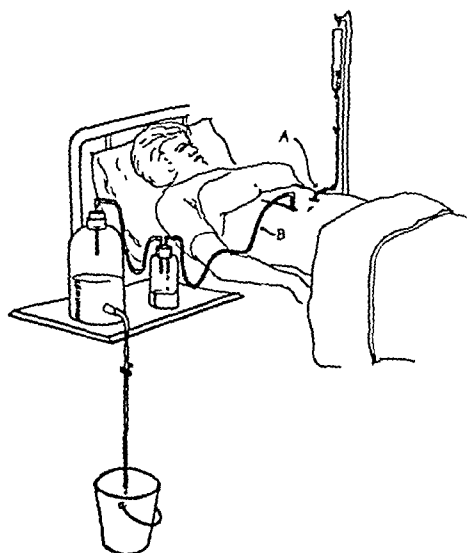
FIG. 3.—Duodenal fistula. A.—Jejunostomy tube. B.—Suction apparatus for duodenal drainage.

DATE		OUNCES
FEBRUARY	23	3 8
	24	4 0
	25	7 7
	26	4 9
	27	6 8
	28	6 3
MARCH	1	4 0
	2	6 1
	3	2 8
	4	2 8
	5	7
	6	0

FIG. 4.—Table. Drainage from duodenal fistula.

patient has to receive the proper amount of nourishment. This can be accomplished by a jejunostomy. Gastrenterostomy with pyloric exclusion does not sidetrack the food completely, as the food can enter the afferent loop and leak out through the fistula.

(2) A complete loss of the pancreatic ferments runs the patient down very rapidly. For this reason, the fluid from the duodenal fistula must be reintroduced into the body through the jejunostomy tube.

(3) The destruction of the structures of the abdominal wall around the fistula is of a fulminating necrotic type and may cause death, unless proper suction is applied.

A case of duodenal fistula, cured by the same method, was presented by Dr. S. Erdman before this Society in 1921.

DR. FRANK S. MATHEWS referred to a patient of his with duodenal fistula following a transduodenal choledochotomy after five days. In addition to prompt use of suction about the fistula, he had attempted to use a duodenal tube inserted by mouth but was unable to get it past the stomach. After a few days a duodenal tube was inserted through the wound into the duodenum and passed

down about ten inches into the jejunum. Through this tube the patient was fed and there was no reflux of the feedings. The fistula finally narrowed down about the tube when mouth feeding began; later the duodenal tube was removed and there was complete healing. By this method of using the tube in the fistula, the patient was spared the operation of jejunostomy.

DR. JOHN A. MCCREERY said that there was a patient with this condition on his service at Bellevue hospital last year following operation for ulcer. Doctor Cunningham was able to control the skin digestion by packing the opening in the fistula with raw meat soaked in hydrochloric acid. The result was very satisfactory, but the cure was not nearly as rapid as that accomplished in Doctor Lewisohn's case.

DR. WILLIAM F. CUNNINGHAM said that in the case referred to by Doctor McCreery he had been advised to use ground beef with hydrochloric acid and shortly after this was put directly over the fistula it closed. They do tend to close spontaneously, but the patients may go downhill so rapidly through loss of fluids that unless jejunostomy or some other form of treatment such as a duodenal tube is used the outcome is disastrous.

RECURRENT CARCINOMA OF SIGMOID, WELL TWO YEARS AFTER SECOND OPERATION

DR. RICHARD LEWISOHN presented a woman, forty-four years old, who was admitted to Mount Sinai Hospital September 22, 1926. Her husband died at another hospital of carcinoma of the rectum. The patient had had diarrhœa and tenesmus for three years, blood in stool for nine months, sometimes bright red, sometimes dark. Epigastric distress for eight months. A barium enema showed a non-obstructing defect in the sigmoid junction. Sigthrombus produced by a chemical irritant in a vein differs from one occurring the anus. A specimen was removed, microscopic examination of which showed an adenocarcinoma.

Operation, October 6.—A five-inch incision was made and an indurated tumor was discovered in the lower sigmoid. There were no liver metastases. The tumor was removed in typical fashion. An end to end anastomosis was performed. The abdomen was closed with drainage.

Microscopic examination showed an adeno-carcinoma with involvement of the regional lymph-nodes. The patient made an uneventful recovery without leakage and was discharged November 1, 1926.

January 31, 1928.—The patient was readmitted. Since one month, she had had blood in her stool. Sigmoidoscopy showed a recurrence. Microscopic examination of a specimen showed adeno-carcinoma.

February 18, 1928.—A preliminary cæcostomy was performed, which was opened eleven days later. The patient passed a large tapeworm through the cæcostomy opening. On March 26, the recurrent carcinoma of the sigmoid was resected. It was possible to reëstablish the lumen by an end-to-end anastomosis. There was a moderate amount of tension. Microscopic report showed adeno-carcinoma. Following the operation there was a considerable amount of discharge of pus and feculent material. The wound on the left side of the abdomen closed in one month. Closure of the cæcostomy was delayed until May 31 as tapeworms reappeared in the stool. Proper treatment removed

the tapeworm radically. The patient left the hospital on June 20, 1928, and has gained forty pounds since her operation.

Doctor Lewisohn stated that this case presented the following points of interest:

(1) Local recurrence can be attacked with good result, instead of considering these cases as inoperable carcinoma and turning them over to radio-therapeuists for treatment;

(2) A cæcostomy is of great value as a temporary measure for sidetracking the intestinal contents. Cæcostomy not only has a place in obstructive cases, but in a certain group of non-obstructive carcinomata of the large bowel.

THE SURGICAL TREATMENT OF URINARY INCONTINENCE IN WOMEN

Dr. Morris K. Smith read a paper with the above title for which see page 394.

Dr. Frederic W. Bancroft said he had performed the Kelly operation for partial laceration of the urethral sphincter muscle on five cases. He had used a small Young's prostatic retractor, which was inserted through the urethra and the prongs spread. By traction this indicated the internal meatus. Then, using the pubis as a fulcrum, the prong portion could be pushed outward and an exposure made. A vertical incision over the urethra, with the tractor in position, permitted the exposure of the sphincter muscle and satisfactory suture. All five cases had shown eminently satisfactory results. In the type of case where the woman tends to urinate when she stumbles or sneezes, this operation, which is a simple procedure, gives a great deal of relief.

Dr. Frank S. Mathews said that although there are many women who are troubled to some degree with lack of urinary control, Doctor Smith's case was one of unusual severity. In the milder cases, at times, a retroversion pessary will give some degree of relief. He believed that Doctor Smith's success in his case was probably not a little due to the suprapublic cystotomy which would have the effect of giving the sutured wound complete rest.

Doctor Smith, in closing the discussion, said that judging from the literature the Kelly operation has been very successful. In his case, however, it failed. It seemed to him that in cases of severe incontinence, diversion of the urine to give the sutures a better chance to heal was a valuable procedure.

BRIEF COMMUNICATIONS

SODIUM ISO–AMYLETHYL BARBITURATE AND SPINAL ANÆSTHESIA

SPINAL anæsthesia is an exceedingly useful form of anæsthesia, and in the past few years has become a very popular one. But many people dread the prospect of being operated upon in a conscious condition, and for them the experience may be an extreme mental ordeal, which may leave on their mind a most vivid impression of suffering. I refer here to the occasional hypersensitive and unstable individual. This aspect of spinal anæsthesia constitutes a serious drawback.

Preliminary narcosis, as with morphine and scopolamine, or with these and a barbiturate by mouth or rectum, is a great help in such cases; but the effect of such narcosis varies so much with different individuals that the patient cannot with certainty and safety be put definitely asleep. This can, however, be done readily and accurately by the intravenous use of sodium iso-amylethyl barbiturate. As the maximum effect of this drug is thus obtained practically instantly, the desired result can be gauged with considerable accuracy.

The combination of this drug, thus administered, with spinal anæsthesia gives a result which is almost ideal. The patient falls asleep, in her own room, quickly, and without any untoward sensations, and awakens there later, utterly oblivious of her trip to the operating room. At the same time her anæsthesia has been such as to give a maximum of desirable operating conditions, and a minimum of organic toxic effects. Post-operative discomfort is much reduced, because there is minimal nausea and vomiting and because there is a prolonged period of drowsiness with considerable amnesia for unpleasant occurrences.

Of course the ordinary technic for the administration of sodium iso-amylethyl barbiturate must be rigidly adhered to, and due allowance made for the rapid lightening of anæsthesia which takes place for a short time after intravenous administration.

The drop in blood-pressure which usually takes place at this time, and which might make one hesitate about giving spinal anæsthesia, may be practically eliminated by giving twenty-five to fifty milligrams of ephedrin before or with the intravenous injection. Skin sensation is usually retained, so that test is readily made for height of anæsthesia.

The combination of intravenous sodium iso-amylethyl barbiturate and spinal anæsthesia has, in our experience with this method in the clinic, put the patients soundly asleep in a most easy and agreeable manner and given

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them an extremely relaxing anæsthesia with a minimum of organic toxic effects and of post-operative discomfort.

LINCOLN F. SISE, M.D.,
Boston, Mass.

From the Lahey Clinic.

ORTHOPNŒA IN ACUTE RUPTURED TUBAL PREGNANCY

SEVERAL uncommon signs are referred to in the recent literature of ectopic pregnancy. Cullen[1] had reported the occurrence of "bluish discoloration about the umbilicus." Rubin[2] called attention to pain in the shoulders in ruptured ectopic pregnancy—a symptom which he attributed to the irritation of the under-surface of the diaphragm by the extravastated blood. Danforth[3] corroborated this sign in two cases which he recorded. Polak[4] emphasized pain on defecation as a frequent complaint. Though numerous authors discuss the symptoms of shock and dyspnœa in the acute stage of tubal rupture, none mention orthopnœa. Neither Schuman,[5] in his textbook on "Extra-uterine Pregnancy," nor Davis,[6] in his discussion of the subject, lists this symptom. Stein[7] reported 160 cases of extra-uterine pregnancy, Hendry[8] analyzed 152 cases, and Brody[9] fifty cases without mention of orthopnœa.

It is because orthopnœa was an outstanding symptom in a recent case that I have thought it worthy of being reported.

Mrs. I. C., aged twenty years, whose past health was excellent, took sick with cramp-like pains in the lower abdomen. This she attributed to a meal of stale chicken, which food had been held over some seventy-two hours. Directly after eating she experienced intense distress, felt faint, and then became nauseated and vomited. Further inquiry brought out a previously normal gastric record, but menstruation was just a bit irregular. The patient had been one week overdue, and then spotted for a few days prior to the onset of the abdominal symptoms. She was sitting upright in bed, hands pressed against the abdomen, breathing in a shallow manner, lips pale, pulse rapid (about 120°). When asked to lie down she attempted to do so but gasped that lying down made her feel faint. In the moment when she was partly recumbent abdominal rigidity was elicited.

Because a vaginal examination was deemed essential we insisted that she lie down. Again she tried. She was not recumbent more than a moment when she cried, "Please let me up, I can't breathe." During the time that she was lying down the pulse rate increased from 120 to 130 and the expression became wan and anxious. It was imperative that she sit up.

On the basis of a delayed menstruation, the pain and rigidity in the lower abdomen, the striking pallor, the rapid pulse in the absence of fever, and an impression of a fullness in the left adnexa in a hasty vaginal examination, we arrived at a diagnosis of probable ruptured ectopic pregnancy. The presence of the persistent orthopnœa clinched this opinion. So marked was this symptom of "orthopnœa" that the patient felt most comfortable when going to the hospital sitting upright in their automobile.

Laboratory examination showed a white blood cell count of 14,000 and red blood cell count of 4,000.

When laparotomy was done, six hours after the onset of symptoms, the peritoneal cavity was full of blood, estimated at 1,000 to 1,500 cubic centimetres. This was

mopped carefully until the uterus and tubes were seen. The left tube was greatly enlarged and bluish in color. In its center there was a fair-sized, ragged tear—a tubal rupture. A salpingectomy was done. The post-operative recovery was rapid and uneventful. (Pathologist reported tubal pregnancy.)

When the patient awoke from the anæsthesia the orthopnœa was gone and her breathing remained easy throughout the stay at the hospital. When seen several months later her breathing was normal and she gave no history of previous respiratory difficulties.

Comment.—To account for the orthopnœa several explanations are offered:

1. *Orthopnœa Increases Vital Capacity.*—Christie and Beams[10] found that the vital capacity in the erect position or sitting position is greater by about 5.5 per cent. than in the horizontal position. Christie attributes this reduction to interference with the movements of the diaphragm when the patient lies down.

We have no reason to suspect a preëxisting reduced vital capacity in this patient. Her heart and lungs had been normal. There was no history of a previous inflammatory disease of the pleura or chest wall. These are the common causes of reduced vital capacity. Others mentioned by Meyers,[11] such as hyperthyroidism, asthma and emphysema, did not obtain in this case. Of course, profuse hæmorrhage may, by sudden reduction in blood volume, alter the vital capacity.

2. *Orthopnœa May Relieve Pain and Hæmorrhage.*—The patient suffered a great deal of pain. She felt most relieved when she was able to place her hands tightly against the abdomen. It is likely that when she sat erect she could exert such pressure better.

The recumbent position may have favored further bleeding, which the erect position helped to control. It is likely that the mass of blood and the pressure of the arms against the abdomen may have been a force, however slight, to control bleeding.

3. *Upright Position Favored Freer Descent of the Diaphragm.*—A considerable quantity of blood would, in the sitting position, sink into the pelvis, while in the horizontal position a portion might find its way upward towards the diaphragm. This might produce an obstacle not so much by the actual mass of blood, perhaps, as by possible irritation from the blood with an admixture of fetal elements.

4. *Fear.*—Many patients when faced with a feeling of impending dissolution prefer the upright position, for in it they seem to have greater strength and greater confidence.

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CHEMICAL OBLITERATION OF VARICOSE VEINS

IMPROVED TECHNIC

THE treatment of varicose veins by chemical obliteration has been in vogue sporadically for seventy-five years, and each time has fallen into disrepute because the technic has been faulty or the solutions advised have been dangerous. To become popular, any method of treatment must be simple enough for the average physician to use, must be free from danger,
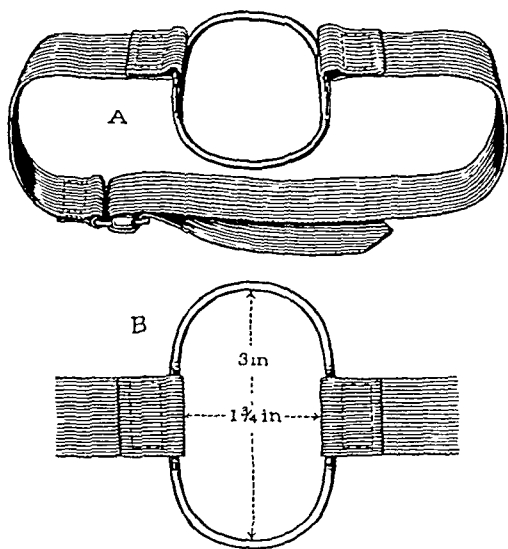
FIG. 1.—Varicose vein occluder.   FIG. 2.—Illustrating the technique of injection with sugar solutions.
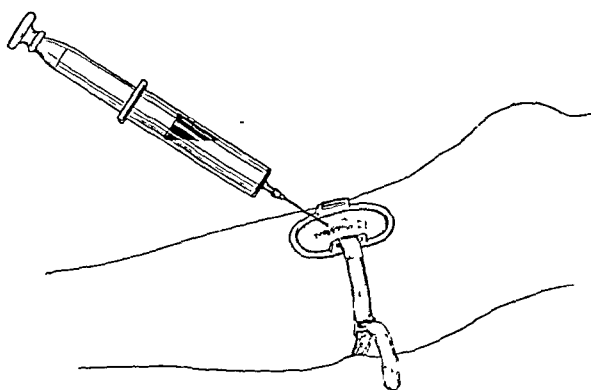
and still be effective in a large percentage of cases. "Injection treatment" of varicose veins, which should properly be called chemical obliteration, has not been generally adopted because of the supposed dangers of pulmonary embolism, and the dangers of either general reactions or local sloughs due to ill-advised solutions.

When emboli from the large veins are feared after every operation, it hardly seems logical deliberately to produce a thrombus in a vein. However, there is sufficient experimental and clinical evidence to prove that the

thrombus produced by a chemical irritant in a vein differs from one occurring in a patient confined to bed. The first is attached to the vein wall by fibrin and later by fibrous tissue, and is not easily dislodged; the latter forms in a normal vein as a result, primarily, of circulatory stagnation, and is easily loosed when the intravascular tension is raised. The fact that few cases of pulmonary embolism have been reported in many thousands of injections further suggests that the probability of its occurring has been overestimated.

Many solutions, while very effective, have brought discredit upon this method of treatment because of the possibility of their producing a systemic reaction or a local slough. In spite of the greatest care and skill, the solution will occasionally be injected into the tissues outside of the vein, or may leak out of the vein into the subcutaneous tissue after the needle is withdrawn. A slough will follow when caustic solutions such as 30 per cent. sodium salicylate, 30 per cent. sodium chloride, or quinine and urethane are used.

All the requirements for a safe and effective chemical are met in the sugar solutions, glucose and invert sugar. These will not produce a general reaction, and injection into the tissues will not produce necrosis. In the free dispensary work, where cost is an important item, I use 60 per cent. glucose prepared and sterilized in fifty-cubic centimetre flasks sealed with wax paper and gauze. In private work I use invert sugar in 60 per cent. and 70 per cent. concentrations. Sugar solutions are not caustic, and for this reason must be kept in contact with the endothelial lining of the vein for a longer period than any of the violent irritants to produce the necessary inflammation for a subsequent thrombosis. This is most satisfactorily accomplished by using a vein occluder (illustrated in Fig. 1). This is a modification of one described by Theis in the J. A. M. A., November 2, 1929. The steel ring is only four millimetres in diameter, so that, when applied to a segment of vein it will occlude without flattening the vein and rendering it invisible. The side arms with the attached elastic straps are two centimetres high, and are not in the way of the operator.

Technic.—The patient is seated on a chair, and rests her foot on a low stool. The leg is slightly dependent so that the veins are easily visible. The occluder is applied over the vein chosen for treatment, and the elastic strap drawn snugly enough to occlude the segment completely. I use ten- and twenty-cubic centimetre luer syringes and twenty-two- to twenty-five-gauge needles. The desired amount of glucose is drawn into the syringe, and the needle inserted into the vein. With the syringe elevated to about 45° above the horizontal, the blood is withdrawn. Being lighter than the solution, the blood flows through the latter without mixing and forms a supernatant layer in the syringe (Fig. 2). After the blood has been aspirated, five to ten cubic centimetres of the solution, depending upon the size of the vein, are injected. Thus, in one operation, the blood is removed and the glucose injected. The needle is then withdrawn, and the patient asked to hold an alcohol sponge over the puncture wound. The occluder is left in position for at least five minutes to hold the glucose in contact with the endothelium long enough to insure the proper degree of inflammation. After it is removed a gauze pad is fastened over the site of injection with adhesive straps drawn tightly

enough to compress the vein. This pad is left on at least four days to produce a flat, invisible, rather than a round, unsightly thrombus.

With this technic no assistant is needed, chances of infection are minimized, and the blood can be removed without any complicated apparatus. By using a number of occluders, injections can be made in rapid succession without loss of time.

In all cases with large varicosities of the long saphenous above the knee I have preceded injections by ligation of the vein at its highest point of dilatation. This has been done for two reasons: First, as a safety measure. Occasionally thrombosis extends proximally from the point of injection. Such thrombi are not attached to the vein wall by inflammatory products, and the possibility of their becoming loose as emboli exists. Second, by preliminary ligation the column of blood is shut off, making subsequent injections more effective. Pressure of blood on the thrombi produced in the vein below is removed, and canalization and recurrence is prevented. This minor operation is easily done under local anæsthesia. A small transverse incision is made, the vein doubly ligated and cut, and the wound closed with a few interrupted silk stitches. A pressure bandage is applied with adhesive tape, and the patient sent home with instructions to continue regular duties. Embolism is less apt to occur in the ambulatory than in the bed patient. There have been no infections and no complications in thirty-four ligations performed since this work was begun in November, 1928. One week after ligation, when it is certain that normal healing is occurring, injections are begun. Usually one injection of 60 per cent. sugar solution below the point of ligation will completely and permanently obliterate the greater portion of the varix.

Because of the ease with which chemical obliteration can be accomplished after simple ligation, and the permanency of such obliteration, I now ligate before injection all large varices in the calf or the popliteal space as well as those above the knee.

CONCLUSIONS

1. Chemical obliteration of small and moderately sized varicose veins can readily be accomplished by means of harmless sugar solutions held in the vein by a simple vein occluder.

2. Large varices have been most satisfactorily treated by a combination of ligation and injection.

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THE TRANSPLEURAL OPERATION FOR SUBPHRENIC ABSCESS

A SECONDARY abscess beneath the diaphragm develops in approximately .6 per cent. of all cases of suppurative appendicitis. It may develop following rupture of a peptic ulcer, gall-bladder infection, or other suppurative lesions of the abdomen. If the abscess develops in the loin or anteriorly in the subhepatic region, the diagnosis is usually made with ease, and its operative approach and drainage can be readily accomplished.

More frequently it is situated on the upper or posterior surface of the liver, where it is protected by the overlapping ribs, and for this reason its

diagnosis is more baffling and the operative approach more arduous. In such cases the condition may be determined only by the history, the presence of a high, fixed diaphragm, and by the exclusion elsewhere of the presence of pus. The surgical problem is to drain the pus by the most direct route without spreading the infection into the pleural space and into the abdominal cavity. This can best be accomplished by a transpleural operation done in two stages. In the first stage the costo-phrenic angle of the pleura is obliterated and in the second stage the diaphragm is incised and the abscess directly reached.
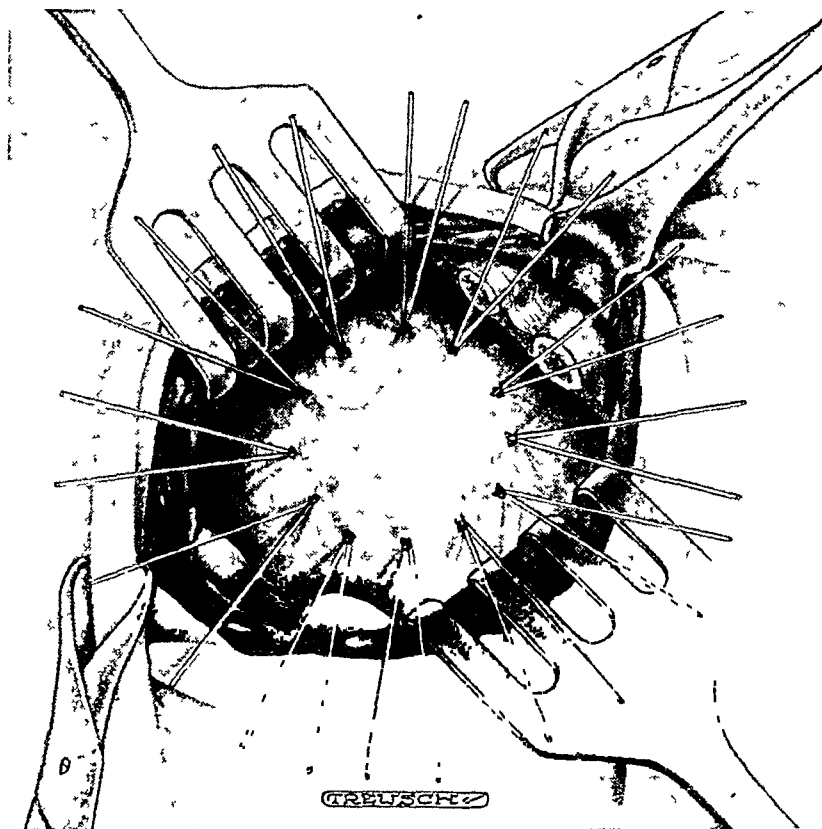
Fig. 1—First stage Sutures have been passed through the diaphragm and pleura to obliterate a portion of the costophrenic angle Sutures are left long to serve as guides at the second stage

The steps of the operation are as follows: Under procaine, or nitrous oxide and oxygen anæsthesia, about two inches of the eighth and ninth ribs in the posterior axillary line are subperiostially excised. The intercostal vessels, nerves and muscles are removed so as to give a clear view of the underlying pleura. The wound is widely retracted, and through the parietal pleura the lung can be seen moving with each respiration. Below the lung the diaphragm, covered by a diaphragmatic pleura, can be seen. The lung is pushed upward and held by a warm gauze pack and the parietal pleura united to the diaphragmatic pleura with eight or ten interrupted sutures of catgut placed in a circle (Fig. 1). The stitches are placed deeply so as to include the diaphragm, and the ends are left long so as to be used as retraction sutures

at the second stage of the operation (Fig. 2). In order to cause firmer adhesions and a safer obliteration of the costo-phrenic angle, the wound is packed with gauze. Forty-eight hours later the gauze is removed. The pleural surfaces will then be adherent. The sutures, previously placed, are used for traction and a large needle can be passed through the diaphragm into the subphrenic space, or an incision imediately made and the space explored with the finger. If pus is not immediately encountered on the top of the liver, this area should be packed off with gauze and the posterior surface of the liver explored with the finger. When the abscess cavity is encountered it should be drained without further exploration or else the protective barrier of the

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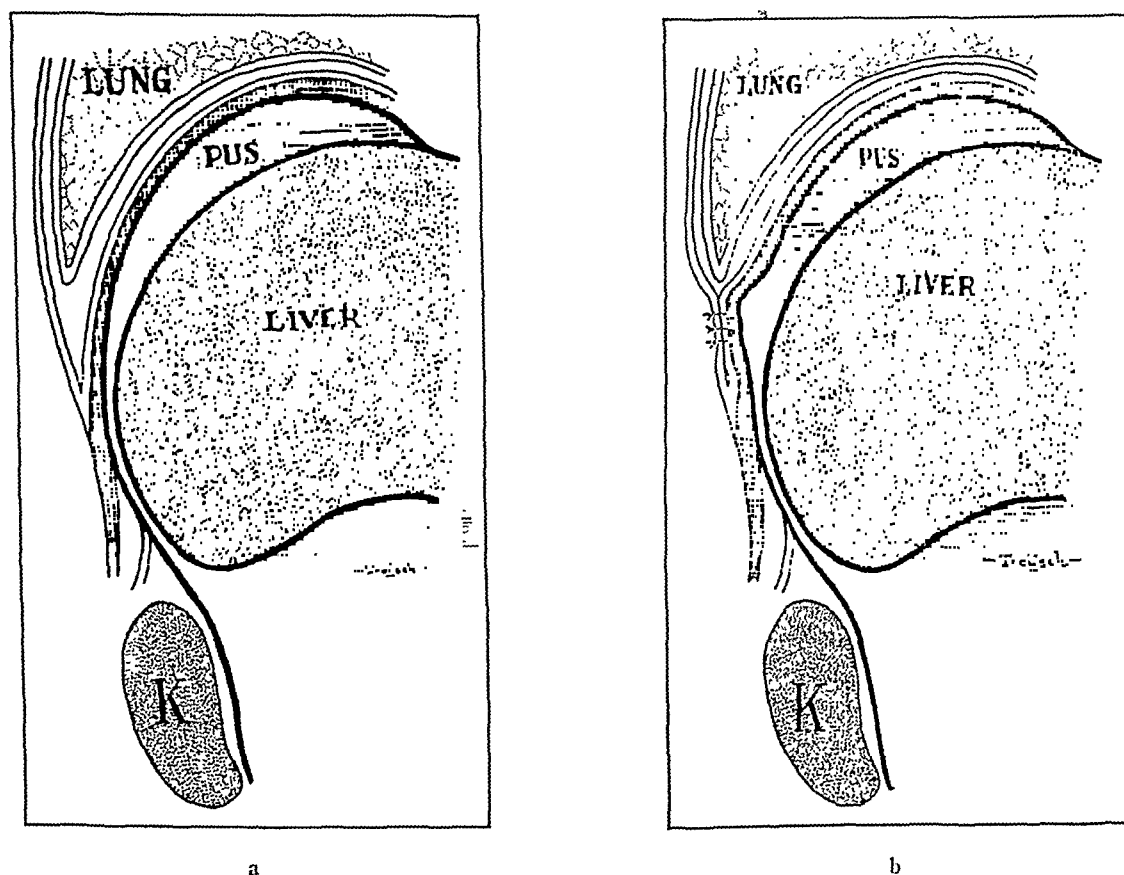
FIG. 2.—(a) This shows the position of the pus in a high subphrenic abscess. (b) The costo-phrenic angle has been obliterated by the sutures. (Modified from Nather and Ochsner.)

abscess wall may be ruptured and the infection spread. Two large rubber tubes are placed in the bottom of the cavity and into each a catheter is placed for irrigation. Walling-off gauze is left in place for forty-eight hours and at this time hourly irrigations with saline solution or surgical solution of chlorinated soda is begun. The drains are removed at the end of a week and smaller, shorter ones substituted. The gradual shortening of the drains, rather than their early removal, will obviate the danger of a recurrence of the abscess and will insure healing and obliteration of the cavity at its deepest point.

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BOOK REVIEWS

DISEASES OF NOSE, THROAT AND EAR, MEDICAL AND SURGICAL. BY WILLIAM LINCOLN BALLENGER, M.D. Cloth; octavo; pp. 1138. Lea and Febiger, Philadelphia, 1930.

In this sixth edition, the author has most painstakingly brought the work up-to-date. The section devoted to the ear is now presented first and in addition to the sound presentation of the anatomy and physiology of the ear, many modern advances have been included. The description in the use of the audiometer, in particular, is well done, as are also the tests for simulated deafness.

The remaining work on the ear is basically sound and is made most lucid by excellent diagrams. This is particularly true with regard to the entire subject of the labyrinth. A most valuable addition to this volume is a large section devoted to peroral endoscopy. This is presented by Drs. Gabriel Tucker and C. L. Jackson, of Philadelphia.

The reviewer feels that this book is one of the most valuable in the entire bibliography of otolaryngology.   HENRY G. BULLWINKEL, M.D.

BURNS. TYPES, PATHOLOGY and MANAGEMENT. By GEORGE T. PACK, B.S., M.D., and A. HOBSON DAVIS, B.S., M.D. 8vo Cloth; pp. 364.

What is a BURN? According to the authors: "A burn is an injury inflicted on the body by a degree of heat higher than is compatible with healthy action in the part affected." This seems a comprehensive and quite simple definition, but in the same paragraph we find coupled with dermatitis *combustionis* dermatitis *congelationis,* the effects of absence of heat! Which shows the difficulty in attempts at classification. The work is nevertheless a timely and somewhat exhaustive discussion, the scope of which is well outlined on its title page. We notice with interest that separate chapters are given to Burns by Electricity, Burns by Lightning, Burns by Röntgen Rays, Burns by Radium, Sun Burns, Burns by Caustic Chemicals, and Burns by War Gases. The authors have compressed much valuable material between the pages of this book and it is presented in a clear and well systematized manner that will make reference to it facile. The subject so common and minor to the ordinary standard is one that really deserves more consideration than the surgical student is apt to give it. Such a book is really timely and important even in this day of transcendental surgery.

LEWIS S. PILCHER.

TRANSACTIONS

OF THE

AMERICAN SURGICAL ASSOCIATION

SEMICENTENNIAL MEETING HELD IN PHILADELPHIA, PA., MAY 15, 16 AND 17, 1930

ADDRESS OF THE PRESIDENT

FIFTY YEARS OF THE AMERICAN SURGICAL ASSOCIATION

BY FRED B. LUND, M.D.

OF BOSTON, MASS.

To BE intrusted with the presidency of the American Surgical Association, which we love só well, membership in which was the goal of our youthful efforts, and which has been so many years, to use the words of its distinguished founder, "the altar on which our best contributions to surgery were laid," filled me first with bewilderment and then with a sense of my own inadequacy. The only repayment I can make for this great honor, which has in the past been given to some of the greatest leaders of our profession, is to attempt to give in my address a brief history of our Society, especially of the earlier years. In the time at my disposal, much, as you will too well realize, must be left out. When your historian speaks as he ought, make the most of it; when he fails, forgive him, remembering that he deeply appreciates the honor of your choice. As Doctor Gerster said, under similar circumstances, and as Horace said before him, "Principibus placuisse viris non ultima laus est," which may be translated, "To have pleased the leaders of our profession brings with it no small satisfaction."

The year of 1879 was perhaps the most important in the history of surgical organization in this country of ours, for that year witnessed the birth of the American Surgical Association, the Philadelphia Academy of Surgery, and the New York Surgical Society. At that time surgery had not been divorced from general medicine. Probably all the leaders who founded the Association still did family practice; in fact, our founder used to pride himself on the importance of his medical practice to his knowledge of surgery. But the field was rapidly expanding, antiseptics had begun and surgery was soon to be a field large enough, much too large, for the undivided efforts of any one man.*

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* The first surgeon to devote himself entirely to surgical practice from the beginning was Dr. William T. Bull, of New York.

That great surgeon and teacher, Dr. Samuel D. Gross, then professor at the Jefferson Medical College in Philadelphia, realized the need of surgical societies for mutual instruction and interchange of opinion, and became the founder of the Philadelphia Academy of Surgery and the American Surgical Association, throwing in for good measure the Pathological Society of Philadelphia. An adequate portrayal of that truly remarkable man would overtax the limits of my address, but a brief sketch must be undertaken.* Doctor Gross was born in Easton, Pennsylvania, in the year 1805, of German parentage, the so-called Pennsylvania Dutch, and their peculiar dialect was his native tongue. He had therefore to begin his professional studies by learning English. He began to study medicine at seventeen as apprentice to a local practitioner, but soon found that he needed preliminary education. He deliberately stopped his medical work for two years and attended an academy at Wilkes-Barre, where he studied Latin, Greek, English and German. At nineteen he began again the study of medicine, which he carried on without interruption for sixty years. So excellent was his grasp of languages and so great his industry that ten months after his graduation in the third class which was graduated from the Jefferson Medical College, he had translated four medical treatises from French and German into English. He wished to begin practice in Philadelphia, but could not afford to spend the necessary time. So he went to work in his native town of Easton, where he soon acquired a practice. In addition to this, he carried on dissections, even driving to Philadelphia, a distance of fifty miles, and bringing back as a companion in his buggy a cadaver for that purpose. He also carried on research requiring animal experimentation. His work attracted attention, and in 1833 he was called to Cincinnati to be Demonstrator of Anatomy in the Medical College of Ohio. At that time it took sixteen days by stage and steamboat to get from Easton to the "Queen City." Here he remained four years and published his "Elements of Pathological Anatomy," the first publication of its kind in the English language, which attracted the favorable comment of the great pathologist Virchow and won its author great renown.

In 1840 he became Professor of Surgery in the University of Kentucky. Here he did much experimental work on wounds of the intestine. In 1856, having refused an invitation to the professorship in the University of Pennsylvania, he came to Philadelphia as Professor of Surgery in the Jefferson Medical College, for he could not refuse the call of his beloved Alma Mater. Here he spent the remainder of his life. In his introductory address he said, "Whatever of life and of health and of strength remain to me, in the presence of Almighty God and of this large assemblage, I dedicate to the cause of my Alma Mater, to the interest of medical science, and to the good of my fellow creatures." This oath he faithfully kept.

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*More adequate biographies have been written by the venerable Doctor Keen and by Dr. John Gibbon, his successors in the professorship at Jefferson, to which I refer those of you who have not read them already, and from which I have obtained much of the material for this sketch.

His contributions to surgical literature were varied, constant and important. Among them, besides his monumental "System of Surgery," were papers on "Foreign Bodies in the Air Passages," on "Diseases of the Urinary Bladder," and whatnot. He was the first to advocate abdominal section in rupture of the bladder, the use of adhesive plaster extension in fractures of the legs, amputation in senile gangrene, and the suture of divided tendons.

He was a man of majestic figure and handsome face, kindly in his judgments, genial, and, above all, industrious beyond belief. He loved men as well as medicine, illustrating the saying of Hippocrates that where there is the love of mankind, there is the love of our art. His personality was most impressive. Dr. W. W. Keen, in an argument in our Society on the importance of hearing rather than merely reading lectures, to illustrate the force of character behind the statements of Doctor Gross, quotes him on the subject of arthritis as saying, with appropriate gestures, "The treatment of inflammation of the joints, gentlemen, is rest; in God's name, gentlemen, rest."

Doctor Mastin writes: "Of commanding presence, with a full, deep voice, master of his subject, thoroughly in earnest, methodical in arrangement, simple yet forcible in expression, never for an instant at a loss for a thought or a word, he was an ideal lecturer; and no other American surgeon has so impressed himself upon medical students and upon so many." In the first years of his professional life, besides his translations which are mentioned above, he was the author of a "Treatise on the Anatomy and Physiology of the Disease of the Bones and Joints," and, in 1839, of the "Elements of Pathological Anatomy."

Such was the founder of our Association, a man who, had he been an ancient Greek, would have been deified at his death, like Æsculapius, and who, as will be seen later, certain members of the Society wished to invest with the purple, and make president for life. He had long desired the establishment of an association which should "bear a national name and embody in an harmonious whole the surgical talent, experience and wisdom of our great country."

Up to that time the American Medical Association had been the clearing-house for American Surgery, and naturally the proposal for a surgical association was made at a meeting of the Association in Atlanta in 1879. Doctor Gross spoke to three of his colleagues, who heartily approved of the plan, and on the following day a meeting was called, at which five leading surgeons from Pennsylvania and the South and West were present, but none from New England, which cannot share in the glory of the birth of our Society, though it soon began to play an important part in its affairs. Those present were Moses Gunn, Professor of Surgery in the Rush Medical College; William T. Briggs, Professor of Surgery in the University of Nashville; W. W. Dawson, Professor of Surgery in the University of Ohio; and L. A. Dugas, the venerable Professor of Surgery in the University

of Georgia, who was chosen chairman of the committee; all professors of surgery—all, so to speak (at that time) frontiersmen, and all pioneers. A circular was sent out to representative surgeons "soliciting their coöperation in the founding of a national surgical society, to consist of distinguished surgical practitioners, writers and teachers, at a meeting to be held in New York at next year's meeting of the American Medical Association." In New York about fifty surgeons assembled, organized and adopted a constitution less than two pages in length, from which we gather that the objects of the Association should be the "cultivation and improvement of the art and science of surgery and the promotion of the interests not only of its fellows, but of the medical profession at large." Fellowship requirements consisted of an age of at least thirty years, graduation from a respectable (sic) medical college, and a reputation as a practitioner, author, teacher, or original observer. Forty-four surgeons signed the constitution.* Samuel D. Gross was elected president and J. R. Weist of Richmond, Indiana, recording secretary. Doctor Weist served as the very efficient secretary of our Association for twelve years, until 1893, and the Association owes him an enormous debt of gratitude.

The next meeting was at Richmond, Virginia, in May, 1881, during the meeting of the A. M. A. After dealing with problems of organization, the Society adjourned to meet in Coney Island in September of the same year. Here for the first time papers were read. Dr. John H. Packard reported "Œsophagotomy without a Guide," "Wound of the Soft Palate," "Infrahyoid Pharyngotomy"; Dr. Kinloch, "A Case of Supposed Aneurysm of the Posterior Tibial Artery." Dr. S. D. Gross read a paper on the "Influence of Operations upon the Prolongation of Life and Permanent Recovery in Cancer of the Breast." No transactions were published.

On May 31, June 1 and 2, 1882, was held the first regular scientific meeting, of which the transactions were published in the same form that they have continued for nearly fifty years. Twenty-five fellows registered and fifty gentlemen from different parts of the country were elected to active fellowship. Fear had been expressed that the Association would harm the Surgical Section of the American Medical Association. Doctor Gross denied this in the following words; "We can hurt no society now in existence or likely to come into existence. We hope to make the American Surgical Association an altar upon which we may annually lay our contributions to Science, and so show to the world that we are earnest and zealous laborers in the interest of human progress and human suffering." He claimed and it has been proven true that the American Medical Association would be strengthened by the new society. At this meeting New England began to see the light and Doctors Cheever, Fifield, George W. Gay and J. Collins Warren, of Boston, were proposed for membership, and at a subsequent meeting were duly elected. They were soon followed by Doctors Hodges, Homans, M. H. Richardson and others.

* Of the forty-four only one, Dr. W. W. Keen, is now living.

It was fitting that this meeting should be held in Philadelphia, the home city of the founder. After wandering about like Leto with the twins, the real birth of the Society, full-fledged and with transactions, took place in this city, where we now celebrate its fiftieth anniversary. The meeting took place just when antisepsis and asepsis were under discussion. It was natural that antisepsis should not at first be successful, for it depended on killing the bacteria with carbolic acid and on the exclusion of air, while not all of those who undertook its ritual realized, as did its illustrious founder, the importance of cleanliness. It was not until several years later that this basic principle of cleanliness was thoroughly understood. A notable paper at this meeting was by James L. Cabell on "Sanitary Conditions in Surgery." It was a plea for Listerism. In the animated discussion which followed, Dr. J. W. S. Gouley stated, "While not a Listerist, I am, as you know, a good sound antiseptist. I cannot conceive of getting good results from hermetically closing wounds after amputations and excision of tumors. I do not think Listerism is going to die. It is dead. Few surgeons will long continue to use it." Dr. R. A. Kinloch replied, "Listerism is not dead. I believe we are going to hear more of it." Dr. George W. Gay showed by his discussion that the so-called antiseptic method had not been thoroughly carried out. Doctor Yandell said in the discussion, "In ovariotomy it has been thoroughly demonstrated. The strongest point seems to be the success and reliability of Dr. John Homans, of Boston."

It is interesting to note the part that Doctor Homans' early laparotomies evidently played in establishing antisepsis in this country. I cannot help digressing a moment to say a word about Doctor Homans, "honest John," as he was called. Surgeon to the northern army in the Civil War, skillful, intelligent, blunt and kindly, careful of his records, and brave as a lion, I feel sorry for the younger men of the Society because they have not the precious memory of him which we older men have. In preparing this address I have been again filled with admiration for the character of his work. At this time he had reported forty-seven cases, with only four deaths, under Listerism. "Many of the participants in the discussion," wrote Doctor Mears later, "felt called upon to deny that either they or any of the surgeons in this or that city employed the system or in any way approved of it." The writer of one of the papers in closing the discussion said, "the great objections came not from those who have tried Listerism, but those who are willing to raise their right hands and swear to God that they have never used it or witnessed its application." By one, the prophetic words, quoted above, were uttered to the effect that antiseptic methods in surgery were not dead, but that we were yet to hear more of them in the future.

The fifth annual meeting was held in Washington in 1884. Doctor Gross might have been reëlected president, had he not absolutely refused the nomination. In fact, in discussing the matter, Doctor Yandell spoke as follows: "Had the constitution conferred upon us the power, we would have put upon him the royal purple, and, hailing him chief among all, had him

wear it for life." Doctor Gross, however, rightly felt that the honor should come to a different man each year, and so be more widely distributed. Dr. E. M. Moore, of Rochester, N. Y., was elected president, and addressed the Society on the "History of Medicine." Doctor Gross was ill at home and his paper on "Wounds of the Intestine," on which he had worked up to the very time of the meeting, was read by Dr. T. G. Richardson. The following telegram was sent to Doctor Gross: "The American Surgical Association has listened with pleasure and profit to your paper, regrets your absence, and sends you the sympathy of its fellows and their hope for your speedy recovery." On the fourth day of the meeting another telegram was sent. which said: "The fellows of the American Surgical Association are unwilling to depart until they are able to learn whether the hope for the improvement of your health has been realized." Three days later Doctor Gross entered into his eternal rest, full of years and honors. He left behind him this Association, strong and successful, which has ever since and will, we hope, forever be an honor to his memory.

At the sixth annual meeting in Washington in 1885, Dr. John B. Roberts, of Philadelphia, read a long and thorough paper on the "Surgery of the Human Brain," which included cerebral localization, middle meningeal hæmorrhage, and cerebral tumor, which the writer states should be operated upon when accessible. Christopher Johnston, of Baltimore, read a paper on "Diagnostic Laparotomy," the first appearance on our records of the exploratory operation. There was a symposium on "Gunshot Wounds of the Intestine" and some members were recorded for and some against operative treatment. At this meeting in 1885 the first of the foreign honorary fellows were elected. These were Paget, Lister, Erichsen, Annandale, von Volkmann, von Nussbaum, von Esmarch, von Czerny, von Billroth, von Langenbeck, Ollier and Verneuil. Dr. J. Collins Warren spoke on the "Healing of Arteries in Man and Animals after Ligation," which was a real contribution to the subject, based on clinical and experimental work.

The next year Dr. Harold C. Ernst spoke on "A Consideration of the Bacteria of Surgical Diseases," based on cultures made in Doctor Warren's wards. The common bacteria of suppuration, staphylococcus aureus and albus, were described, also the organism of erysipelas, "very similar under the microscope and in its behavior to staining reagents to the others, but there is quite a difference in the appearance of the colony." P. S. Conner, of Cincinnati, read a paper on "Tetanus," in which he concluded that the cause of the disease must be a virus from breaking-down tissue, or a germ— a very careful discussion which went as far as one could before the bacillus was discovered.

In 1888, Dr. W. W. Keen reported three successful cases of cerebral surgery, including the removal of a large intracranial fibroma. These were a pleasant contrast to the almost uniformly unsuccessful cases previously reported in our Transactions. This meeting was in Washington and was the first meeting with the Congress of American Physicians. At the meeting of

our Association in 1886 Dr. Claudius H. Mastin had proposed the holding of this Congress. His proposal was adopted by the Society and through his efforts and that of a committee appointed at that time it was brought about. Its value to the associations composing it and to American Medicine can hardly be exaggerated.

It is interesting in looking over the record to find that in some of these early meetings of the Society only four papers were presented at a meeting. This was in order that there might not be too many for adequate discussion, which our founders considered very important. Doctor Senn used frequently to write papers of two hundred and fifty pages, on such topics as "Surgery of the Pancreas" or "Gunshot Wounds of the Intestine," in which he did pioneer work. Other subjects that he treated were "Air Embolism" and the "Relation of Microörganisms to Surgical Disease." Senn's plates we all remember, and how soon they were superseded by Murphy's button! Verily, there were giants in those days. Today we have many more papers and some of the shortest are the best. In the words of the old minister to the young candidate on the length of sermons, "Few souls are saved after the first fifteen minutes."

In the early days of the Society long tables were placed at the end of the papers, giving all the examples of the operation collected from literature. This was a tremendous task, but supposed to be necessary to establish mortality. It did so, but the mortality was bound to be high and the statistics uncertain on account of the varying conditions under which the operations were done.

In 1889, Dr. David W. Cheever was president and made a presidential address of notable literary quality, entitled "The Future of Surgery without Limit," from which I quote: "Long since it was said that all was found out and that Anatomy and Surgery had nearly reached their limit. Far from this, the microscope has created a new anatomy and a new pathology. Anæsthesia enlarged surgery. Antisepsis emboldens surgery, and we can set no limit to the advance." The three sacred cavities, the abdomen, which means hidden, the thorax, which holds two feet of the tripod of life, the skull, which conceals the nerve force, the vital principle, are all explored. He gave under the heading of operations as yet *subjudice*: "Resection of the pylorus, resection of cancerous intestine, of omentum; removal of the spleen, of large bronchoceles, of the larynx, the pancreas, the prostate gland, the normal ovary; fixation of the kidney, of the uterus; puncture of the pericardium; opening gangrenous abscesses in the lungs; tapping of the ventricles of the brain." It is easy to see that all these except the removal of the normal ovary are recognized procedures today. In fact, today, surgery has even extended to the last remaining glandular structure, the adrenal gland, and the last remaining system, the sympathetic nervous system.

Dr. J. Collins Warren spoke on the "Early Diagnosis of Malignant Disease" and presented the "Mixter Punch." Dr. George W. Gay spoke on "Heaton's Operation for Hernia." It is interesting to note that at that time

the "injection of infusion of white oak bark" was taken seriously as a treatment.

In 1890, Dr. W. T. Bull spoke on the "Radical Cure of Hernia" and reported one hundred thirty-four operations with three deaths. He deprecated undue haste in reporting results, and advocated high ligature of the sac without suture of the ring. In a notable discussion in 1895 on hernia Doctor McBurney condemned his own operation as having thirty per cent. of failures and advocated the operations of Bassini and Halsted. His attitude toward his own operation was a striking example of scientific honesty, and did honor to himself and to our Association. At this time operations for appendicitis in the interval began to crop up. Doctors F. S. Dennis and C. B. Porter spoke on the "Propriety of Removing the Appendix in the Interval," the first appearance of this subject. The first paper on appendicitis that I could find in the Transactions was read by Dr. W. T. Bull in 1888, entitled, "The Surgical Treatment of Typhlitis and Perityphlitis," although Fitz had suggested the name "appendicitis" in 1886. At the present time we might well discuss the propriety of the removal of the appendix from those who do not need the operation. At this meeting Dr. A. G. Gerster, that charming gentleman and eminent surgeon, sportsman and scholar, who had come to New York as an immigrant from Hungary and became one of America's leading surgeons, was proposed for fellowship.

In 1889, Dr. H. L. Stimson, one of the founders of the New York Surgical Society, and the father of our present Secretary of State, the Honorable Henry L. Stimson, in a paper entitled "Modifications in the Technique of Abdominal Surgery," limiting the use of the ligature *en masse*, reported four cases of hysterectomy with ligature of the uterine and ovarian arteries. This was a brilliant step in advance, doing away as it did with the old ecraseur and the external treatment of the stump, one of the saddest memories of our surgical youth. "Digital Divulsion of the Pylorus for Cicatricial Stenosis" by Dr. J. M. Barton described one of the first hesitating steps in gastric surgery.

In 1891, in Washington, Dr. Claudius W. Mastin was president and addressed the Society on "The Example and Teachings of Samuel D. Gross." He proposed a monument to his memory. A committee was appointed, and with the assistance of the Jefferson Alumni and a few private friends, the money was raised. The meeting of 1897 in Washington, when the statue was unveiled, was one of the notable meetings of the Association and will be discussed in due order.

Dr. A. G. Gerster's important paper on "Asepsis" illustrated the progress made since the early beginnings, and was perhaps the first to crystallize our present views. Among other things he noted the following fact, familiar to us all in the early days, "A clumsy and rough operator who is a thorough antiseptician is often very successful, while dexterous men meet disheartening discomfitures on account of disregard of the maxims of cleanliness. The living spark of truth has survived the pedantry and zeal of the advocates as

well as the sneers and contempt of the opponents of the new departure." Doctor Gerster introduced Kraske's operation to the Society. He had done it seven times with one death.

Dr. J. C. Warren spoke on "Asepsis" at the large hospitals in Boston, with a description of the new laparotomy ward at the Massachusetts General Hospital, a remarkably well-equipped building at that time, when the peritoneum was supposed to need special aseptic precautions and was not, as at present, known to be less susceptible to infection than other parts of the body—the joints for instance.

Dr. M. H. Richardson, on the surgery of the gall-bladder, was ahead of his time for he recommends in favorable cases the excision of the gall-bladder, "though he has done it only once." For drainage he advocated suture to the abdominal wall over a wide margin.

Dr. S. J. Mixter, who afterward contributed so much of value to our meetings and became our president, read his first paper before the Society on "Dislocations of the Semilunar Cartilages." Dr. John B. Deaver advocated early operation in appendicitis. I am told that even now, after thirty years have passed, he still holds the same views.

In 1894, Dr. John S. Billings (by invitation) spoke on "Methods of Teaching in Surgery." He recommended that future surgeons should be trained in Bacteriology, Pathology and Physiology. He also suggested an occasional interchange of professors, an idea which has been so successfully carried out since.

At the meeting in 1895, Doctor Coley introduced the "Treatment of Inoperable Tumors with Toxins of Erysipelas and Bacillus Prodigiosus." Dr. L. McLane Tiffany was president and addressed the Association on "Intracranial Resection of the Gasserian Ganglion," and Dr. A. T. Cabot gave the *coup de grace* to castration as against prostatectomy.

The next year, 1896, Dr. DeForest Willard spoke on "X-ray Skiagrams" (sic), and X-ray reproductions appear in our transactions for the first time. Somewhat crude they were and concerned entirely with the bones and joints, but very interesting from the point of view of surgical history. The following year Dr. J. William White read a paper entitled, "The X-ray in Surgery," and "hoped that they might prove of use in fractures." Prophetic words! They have proved of use in fractures, and also of use to those prosecuting suits for malpractice, for like most good things they may do harm, especially if we look so keenly at the deformity in the picture that we are dissatisfied, even though the functional result leaves little to be desired. In 1903, the subject of X-ray as a therapeutic agent was brought up for the first time by Bevan and Coley.

In 1897, the Association met in Washington under the presidency of J. Collins Warren, and the statue of Samuel D. Gross was dedicated. This volume of the Transactions contains the photograph of the statue and the wonderful addresses of Doctor Mastin and Doctor Keen. It was one of the greatest meetings of our Society. Doctor Warren spoke on "The Influence

of Anæsthesia in Surgery." I quote his closing words: "The old Massachusetts General Hospital stands as it did in 1846, with its sightly Bulfinch dome and granite columns. From a scientific standpoint it seems an antiquated structure in comparison with the modern pavilion, wards, laboratories, and operating theaters which surround it, but it will never be torn down. It will always remain one of the conspicuous landmarks of this wonderful century, as a shrine of surgery sacred to that moment 'when the fiercest extremity of suffering was steeped in the waters of forgetfulness and the deepest furrow in the knotted brow of agony was smoothed away forever.'"

The next year, 1898, in New Orleans, Doctor Halsted read his paper on "Cancer of the Breast." On the work here described, the modern radical operation is founded.

In 1899, Doctor Keen was president. His address was on "Total Laryngectomy." This year, Dr. H. W. Cushing brought out his right-angled continuous intestinal suture. As a result of the Spanish War there were several papers on military surgery. In a discussion on aseptic surgery, under the lead of our foreign guest, Dr. Theodore Kocher, the use of gloves was advocated, at that time a new thing. How much it has meant in the years that have followed for the safety both of patient and surgeon!

Nineteen hundred saw the first real entrance of the Association into the great field of gastric surgery with Doctor Weir's presidential address on "Perforating Ulcer of the Duodenum." Finney and Richardson also spoke on gastric surgery. William J. Mayo, a promising young surgeon from the Middle West, had had three cases of pyloroplasty and partial gastrectomy for cancer. How much has developed from the small beginning of thirty years ago! At the following meeting the vicious circle after gastroenterostomy was first discussed by Thomas McGraw, of Detroit, the inventor of the McGraw ligature, as you will remember. In 1902, Doctor Finney brought out his method of pyloroplasty. Everyone felt that he would like to have thought of that himself. Dr. W. J. Mayo brought up the subject of complications following gastroenterostomy. In 1903, Von Mickulicz was our guest and his topic was "The Surgery of the Gastrointestinal Tract." Here gastrojejunal ulcer makes its first appearance in our records. Sir Berkeley Moynihan, now Lord Moynihan, who since has contributed often and generously to our meetings, spoke on "The Surgery of Benign Disease of the Stomach."

In 1901, pancreatitis appeared with our foreign guest, Mr. A. W. Mayo Robson, and W. J. Mayo brought out the transverse suture of umbilical hernia. I believe there has not been a single meeting since without some contribution from either "Will" or "Charlie" or some other of the many distinguished surgeons of the Mayo Clinic.

At Albany, in 1902, the meeting was noteworthy for a symposium on "The Teaching of Surgery," at which Dr. Herbert L. Burrell introduced for the first time the subject of case teaching. This was an adaptation of a method employed at the Harvard Law School in the teaching of Law. It was introduced at the Harvard Medical School by Doctors Walter B. Cannon

and John Bapst Blake. Doctor Rixford reported two cases of exophthalmic goitre, the first mention of the subject in the Transactions, and Matas brought out his radical cure of aneurism by endoaneurismorrhaphy.

Dr. M. H. Richardson was president, in 1903, and addressed the Society on the "Contributions of Surgery to Internal Medicine," in which he paid a remarkable tribute to Dr. John Homans. Coley reported the results of Bassini's operation in a thousand cases.

In 1904, Dr. C. H. Mayo appears with a "Report of Fifty Cases of Thyroidectomy in Exophthalmic Goitre." Since then several operations for this disease have been added to the list of his clinic. The first paper on Cystoscopy and Urethral Catheterization was read by A. T. Cabot.

In 1905, Professor Trendelenberg was our guest. Mr. C. W. Ballance, of London, read on "Experiences in Intracranial Surgery." Among other things, he said, "Cases of brain tumor requiring surgical relief are numerous and widely distributed, but those who operate on them, especially on brain tumors, are few and far between."

In 1909, Geo. W. Crile introduced for the first time in surgical history blood transfusion as a practical life-saving method. Is not this something for our Society and for American Surgery to be proud of? Think of the lives it has saved both in peace and under the difficulties of the Great War!

At Denver, in 1911, Doctor Mayo reported end-results in one thousand cases of ulcer of the stomach. Doctor Crile presented "Anoci Association" and Doctor Cushing "Control of Hæmorrhage in Operations for Tumor of the Brain."

The operative treatment of fractures was beginning to come to the front and Dr. Edward Martin opened a symposium on that subject. Diverticulitis appeared for the first time. This was at Montreal and Doctor Gerster presided. The papers were by W. J. Mayo and G. E. Brewer. Dr. Charles H. Peck presented "Intratracheal Anæsthesia."

In 1913, came Francis T. Stewart with five cases of suture of the heart.

In 1914, under the presidency of W. J. Mayo, Brewer and Cole read a paper on "Lesions of the Stomach and Duodenum." With Lilienthal on "Pulmonary Abscess and Bronchiectasis," thoracic surgery began to come into its own.

In 1915, the symposium was on the surgery of the spleen.

In 1917, Dr. Samuel J. Mixter presided and made a most important address on the surgical problems of the war. The symposium was on the surgery of the large intestine. As was natural, during these years the surgery of the Great War took up most of the attention of this Society.

In 1919, Doctor Pilcher's presidential address was on the subject of "The Influence of War Surgery on Civil Practice."

Our guest this year was the great Belgian surgeon, dePage, who spoke on "General Considerations in the Treatment of War Wounds." The importance and extent of Doctor dePage's war service and the recent death

of Mrs. dePage in the Lusitania lent a tragic interest to his appearance before the Society.

In 1920, Brewer's presidential address detailed the service of the Society during the war, a service in which we may well take pride. Eighty-three per cent. of the fellows volunteered for the war, or ninety-six in all; fifty-seven served in France, forty-eight in this country, and eleven in the French and British armies. The work of Joseph A. Blake at Neuilly and of Brewer himself and our many surgical consultants and operators at the front—Pool, Gibbon, Jopson and many others—redounded to the honor of themselves and the Association. Our fellows received twenty-two decorations and ten citations. We had a brigadier-general, Dr. Finney, whom we all delight to honor. His official family, in 1918, consisted of Majors Peck, Fisher, Harte and J. L. Yates. We had twenty-five colonels, thirty-seven lieutenant-colonels, thirty-one majors, seven captains, and four first lieutenants. The address, based on the experiences of the late war, dealt with the best method for the army to avail itself of civilian surgeons in war.

The venerable Doctor Keen wore the uniform of a major. This was the fourth war in which he had served his country in the ranks. Many of the older men past the age limit were allowed by special dispensation to enter active service, and those still older, like Doctor Keen and many others, served on the draft boards with interest and efficiency, or made invaluable consultants in the office of the Surgeon-General. While we as a Society are proud of our war work, to our members as individuals the memory of their gallant service for their country in France will be a source of pride and satisfaction as long as life shall last. Of the last ten years since the war, which is fresh in the memories of most of us, I shall mention but a few of the more important contributions: Doctor McArthur's presidential address on "Repair of the Common Duct"; Doctor Crile on "The Bipolar Theory of the Nature of Cancer"; and Dr. Harvey Cushing's presidential address on "Orbito-ethmoidal Osteomata." Thoracic Surgery has not been neglected since Lilienthal, Willy Meyer and others have made notable contributions to this subject. Dr. Elliott C. Cutler contributed for the first time in surgical history a report on "Surgical Treatment of Valvular Disease of the Heart."

It has been generally admitted, said Henry Rogers, in a commencement oration on the fiftieth anniversary of his graduation, that the first seventy-five years of a man's life are among his best years. Not so of our Society, which, at fifty years, has just begun to live. It has been true to the ideals of that remarkable man, its founder, through fifty years of unexampled change, during which our art has progressed with a rapidity that takes away the breath of the conservative. In non-professional fields, men have learned to fly (witness the North Pole and the South); with the human voice to put a girdle around the earth in a split second, and that without a wire to conduct the message; by talking motion pictures to preserve forever not only the features and form, but the speech and motions of men. So in surgery in this fifty years have come the wonders of radiation, direct examination of the urinary tract

by cystoscopy and pyelography, of the intestinal tract by the opaque meal, of the gall-bladder by the brilliant functional test of Graham, a member of our Society, and transfusion, which was for the first time in history made practicable by one of our own members. As the progress of science in physics, chemistry and electricity has been in these fifty years unprecedented, so our profession has been on the alert to avail itself of every step in advance, and to apply it in practice to diagnosis and therapeutics. So that it must be acknowledged as true that the marvelous advance in our art has only been made possible by the progress in general science.

It is an interesting thought that within these fifty years the American Surgical Association has taken part in a surgical renaissance. And a renaissance in surgery, which has been defined (inadequately) as the mechanical department of therapeutics, always corresponds with a rena'ssance in medicine and science.

The first great renaissance in surgery, of which we have written records, took place in the fifth century B.C., when the school of Hippocrates, at the time of the great flowering of art and letters in Greece, during the so-called age of Pericles, brought our art to a state of development that had to last it for two thousand years.

The second renaissance, which is known as *the* renaissance came in the fifteenth century with a revival of the Greek learning which had been kept alive by the Arabs during the dark ages, and soon, under Vesalius, Harvey, Malpighi, Paré and others, aided by the discovery of the microscope, a steady and remarkable progress began, which was limited, however, by the absence of anæsthesia. With the discovery in 1848 of ether and chloroform, a new era began, and the suffering from surgical operations was eliminated, but the very fact that the amount of surgery was enormously increased crowded the hospitals with septicæmia and pyæmia. A horrible death might follow the simplest operation. Conditions were such that it is hard for us who live under modern conditions to realize what our predecessors must have gone through.

Then came Pasteur, Lister, antisepsis and asepsis, and about this time our Association was founded. Under these conditions a third renaissance began, and is still in progress. Those of us who have striven to keep up with it for forty years realize how rapid it has been. The pace has steadily accelerated. The reason for the rapidity and extent of this progress is the coincident advance in knowledge of science, chemistry, physiology, electricity, and so on, which are now taking place. I have tried inadequately to sketch in a few words the part played in this progress by our Association and its members. Much work and many names of those who have deserved well of their fellows and of our art will be left out, but that the limitations of time make necessary.

In science, radium has revolutionized the atomic theory so that something like the transmutation of metals does take place, and in medicine, radium wonderful to relate, has both produced and destroyed cancer.

The electric cautery knife has extended the field and saves the time of the operator on the brain and on cancer, to the great benefit of the patient. Ultra-violet rays, lipiodol injections, the delineation of the ventricles of the brain by X-ray and air injections are among the diagnostic aids which science has provided. Infections of the most formidable kind have yielded to the Carrell Dakin treatment, the discovery of a member of our Society. By this, during the Great War, thousands of lives and limbs were saved.

Surgical technic we have so improved that the mortality of operations for exophthalmic goitre, taking all cases as they come, has fallen in many clinics to a small fraction of one per cent. The formidable procedure of resection of the stomach carries with it a comparatively low mortality, and in operations for trifacial neuralgia, resection of the sensory root, hundreds of operations have been performed with no mortality at all. The surgery of cerebral tumors has been advanced to a position far ahead of anything ever done before, and the leader in this work has been Harvey Cushing, a member and former president of our Association. Dr. Charles Frasier, of this city, another member of our Society, has contributed much also in this department of our art. For tuberculosis of the bones and joints, the perfection of modern apparatus for artificial heliotherapy has accomplished wonders, because the substitute sun, so to speak, is able to function indoors during the storms of winter.

Other important matters to be found in our Transactions are the work of Bloodgood, on Breast Tumors and the Pathology of Bone Tumors; of Codman on Bone Sarcoma; Porter on Skin Grafting in X-ray burns, and a long list of contributions by other members, many of them perhaps fully as important as those which have been mentioned. In the choice of subjects for mention I have attempted to illustrate the gradual invasion of new fields during the years under discussion, and, in particular, the first appearance of each subject in the ANNALS of the Society. The work of Dr. Rudolph Matas, our surgeon and scholar, who for many years has contributed so largely to our knowledge of the surgery of the blood-vessels, should not be forgotten. But how can I bring you all in? The appreciation of your work I have to the full, but time and space forbid.

During the last twenty years the surgery of the spleen has thrown much light on many diseases of the blood system, so that we are gradually learning when the spleen ought and when it ought not to be removed. The operations of splenectomy and transfusion in pernicious anæmia, however, are no longer necessary because the liver feeding of Minot and Murphy has proved so successful. It would seem true of medicine as well as surgery that the future is without limit. Adson, of the Mayo Clinic, and others have presented to us the results of advanced work on the sympathetic nervous system.

The improvements in anæsthesia have, especially in the last ten years, contributed enormously to increase the safety of our work. Ether and chloroform by inhalation, the old stand-bys, once the object of many a controversy as to which was better, have given way to nitrous oxide, ethylene, local.

regional and spinal anæsthesia, with their various combinations and sequences, not to mention anæsthesia by the barbituric acid compounds. Spinal anæsthesia alone has a tremendously complicated technic, on which volumes have been written, and is a field large enough to keep any man busy. There is tremendous activity at the present time in this field. The profession of anæsthetist has become an honorable and important one. A result is that by the adaptation of the method of anæsthesia to the needs of the particular patient, shock has been diminished, difficult and complicated operations made safe and easy, and the mortality greatly lessened. Consultations between the surgeon and anæsthetist and intimate knowledge of the work of each on the part of the other have contributed to this result.

Compare the operating room of today with its glass and shiny metal, its smooth walls and floor, its shadowless lighting, with the crowded and often dusty theatres in which the founders of our Society did their work. If we could look forward fifty years, would we see as great a change in conditions? It is hard to believe, but by no means impossible. When we think of the immense benefit to humanity which has resulted from all this progress, we are thankful for it and for the part in it taken by our own members. And yet the change is confined to the externals of our profession, the heart and brain within, the courage, the kindness, the observation, the intelligence, were the same in our founders that they are in ourselves. Perhaps they are entitled to the greater credit because they accomplished so much under such difficult and discouraging conditions. But however that may be, we have the benefit of all these refinements. For this we ought to be thankful and endeavor to contribute our own share to the advancement of our art. We know more than our fathers; our sons know more than we. How much modern blood chemistry and biophysics mean, not only to medicine, but to surgery! Insulin and the careful work of Joslin and others in the treatment of diabetes have enormously reduced the mortality of the surgery of this disease. Chemical and physiological investigations have here gone hand in hand with refinements of technic. In the prophetic words of Doctor Cheever, as true now as they were forty years ago, "the future of surgery is without limit."

During the fifty years' life of our Association, other surgical societies have come into existence, such as the Society of Clinical Surgery, and like small associations for clinical study and travel. These societies, in which many of our own members have been active, have served a most useful purpose, but our Society has remained, in the words of its founder, "the altar on which our best contributions are laid." Clinical societies have done much in fostering the spirit of travel and observation, which has been so important in this country, and, among other things, has cemented most lasting friendships between surgeons living at great distances. The conquering of time and space has made travel easy, and much of the time of any progressive surgeon is devoted to travel both in this country and abroad. As I write, the Lindberghs have flown from California to New York in fourteen hours.

It may be common before long to hop over from California to New York for a consultation.

During the past thirty years the great private clinics have been established in this country, beginning with the Mayos', which proved so well its efficiency that similar organizations have sprung up all over the country. Loose associations for mutual help in practice we have always had, but these clinics have done much to make the service efficient and economical for the patient. The parent of them all has now grown into an educational institution, a foundation, with degrees, diplomas and everything complete. It is a Mecca for surgeons from all over the world, and its influence for good on surgical science and practice has been invaluable. We believe it is only on the threshold of its career.

In his presidential address seventeen years ago, Dr. Charles A. Powers asked the question, "Have we a distinctive school of surgery in this country?" He concludes that we have, especially in the sense of breadth of view and of catholicism, in consideration of the best interests of the patient, attention to anæsthesia, and everything which conduces to the patient's comfort and welfare. What was true then is still more true today. Surgery attracts the best of our young men, men with high ideals and noble purposes. The quality of those entering our profession improves from year to year.

The officers of this Association, the secretaries, treasurers and council have attended faithfully to their duties and devised from time to time changes in the constitution and by-laws, which have been always carefully and judiciously considered. This has been a labor of love, but the manner of its performance has enabled our Society to continue its high standards through these fifty years.

During the life of our Association medical education in our country has been enormously benefited by the closing of large numbers of inadequate and unethical schools and by the improvement and expansion of the better schools, which are really the only ones left.

This beneficent work has been done by the Committee on Education of the American Medical Association, but the leading spirit in this work, the chairman of the committee for years, the first-class fighting man, who put it across, was Dr. Arthur Dean Bevan, an honored member of our Association. This suppression of the inadequate schools has been attended by an enormous improvement in the schools that have survived. Endowments have flowed freely to the better schools, professors are called from one school to another, and every effort is made to secure the very best men for the professional positions.

During these fifty years, many eminent European surgeons, besides those whom we have mentioned, have honored us by their presence and been elected honorary members of our Association. Among them are Bastianelli, Sir Anthony Bowlby, Chutro, Hartmann, Leriche, Lorthioir, Sir George Makins. DeMartel, Sir Thomas Myles, Sir D'Arcy Power, Sir Harold Stiles, Sir Cuthbert Wallace, Charles Walther, and others. The debt of our Society

to these men and others across the water who have come to our meetings and given us of their work is very great. In the youth of some of us older members, we went abroad to study. Many of our very best surgeons are indebted to foreign travel in their youth for the benefits conferred by laboratory study at first hand under the great masters of that day, from whom they learned not only technic, but a thorough training in the spirit and methods of scientific investigation. But once a surgeon, always a student. Now, though it may not be as necessary as of old to go abroad for preliminary training, the benefits which we have had and probably shall get from visits to European clinics can hardly be exaggerated. From continental Europe in the early days came some of our own members, whose knowledge of physiology and pathology helped us in our many difficulties—men such as Christian Fenger, in Chicago, and Gerster, in New York. It has been fortunate for us, too, that Canada, for the purposes of our Society, has not been a foreign country. The communications of some of our Canadian members, witness, for instance, Archibald on Thoracic Surgery, could hardly have been spared from our meetings.

It is a beautiful Greek legend that made Philosophy the daughter of Wonder. We wonder what the reasons for what we see are and try to find them out. Felix qui potuit rerum cognoscere causas. "Happy the man who knows the reasons for things." Modern science, having first transformed the atom, which forms the basis of matter, into a little universe of electrons an immense distance apart, has now transformed it again into vibrations of a hypothetical ether. Surely matter has become something very like spirit. Our stout old Hebrew God didn't do anything so wonderful when he made the earth out of nothing. It is made out of nothing, at least nothing that we can understand. God becomes like the poet who gave to airy nothings "a local habitation and a name." "And when the lofty towers, the gorgeous palaces, the solemn temples, the great globe itself, aye, all that it inherit, shall dissolve, and, like this unsubstantial pageant faded, leave not a wrack behind," there will still be left something very like the spirit of God moving over the waters or at least over the ether, whatever that is. So much for philosophy.

A member of our Association must be a surgeon, teacher and lover of mankind, according to our constitution. May we and those who follow work as hard as did our predecessors in rerum causas cognoscendo; may our love for mankind and of our art go on from strength to strength. If so, the record of our beloved Association in the future will surpass even its proud record in the past.

EXPERIENCES WITH THE TRENDELENBURG OPERATION FOR PULMONARY EMBOLISM

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AT THE German Surgical Congress of 1908, Trendelenburg reported his experimental research on embolectomy of the pulmonary artery, and at the same time described the first two operations for pulmonary embolism in man. One of these, performed by his assistant, Sievers, succeeded in so far that the patient survived the operation for fifteen hours; shortly afterward, another patient operated upon personally by him survived for thirty-seven hours.

Since Trendelenburg's report, some thirty operations for pulmonary embolism have been published or briefly mentioned in the literature. It is probable, however, that the number of such operations which, because they have been unsuccessful, have been regarded as not meriting publication, is far greater.

The cases where the patient has survived the operation, so far as I have been able to find, are the following:

Operator	Year	Survived Operation for
Sievers-Trendelenburg	1908	Fifteen hours .
Trendelenburg	1908	Thirty-seven hours
Kruger	1909	Five and one-quarter days
Schumacher-Sauerbruch	1914	Fifty hours
Kirschner, Konigsberg	1924	Discharged healed
Meyer, Charlottenburg	1927	Discharged healed
Crafoord, Morby Hospital, Sweden Dir. Dr. Giertz	1927	Discharged healed
Nystrom, University Hospital Uppsala, Sweden	1927	Thirty hours
Nystrom, Uppsala, Sweden	1927	Five hours
Nystrom, Uppsala, Sweden	1928	Discharged healed
Meyer, Charlottenburg	1928	Discharged healed
Nystrom,* Uppsala, Sweden	1929	Three hours
Nystrom, Uppsala, Sweden	1929	Discharged healed

* Wrong diagnosis, uræmia.

It is desirable that in the future, not only the successful, but also the unsuccessful cases of Trendelenburg's operation be carefully described and published, as there is need of larger empiric material, both for fixing the indications for the operation, and for perfecting its technic.

In fatal cases of pulmonary embolism, death frequently ensues immediately, or within a few minutes, but in most cases only after more than five minutes have elapsed, and in about half the cases, according to the data collected from various sources, more than ten minutes after the onset

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of the attack. Not infrequently it is only by repeated embolisms in the course of several hours or days that complete obstruction is reached which takes the life of the patient.

It is generally held that in those cases where the embolic catastrophe is instantaneously fatal, it is hopeless, even with the best organization, to attempt the operative removal of the obstruction in the pulmonary artery. But it is difficult to say where the line for operability has to be drawn, because, so far, we have not the necessary experience with regard to the length of time during which, under different conditions, the pulmonary artery can remain obstructed before the interruption of the circulation is sufficient to be fatal.

In experiments upon rabbits, Laewen and Sievers found that obstruction would cause death if lasting more than two and one-half minutes. But by the aid of different kinds of resuscitative measures, *i. e.*, artificial breathing, with oxygen, injection of adrenalin into the heart, *etc.*, the animals could be revived, even if the obstruction had been prolonged seven to eight minutes.

Trendelenburg states that embolectomy must be performed within forty-five seconds after obstruction of the pulmonary artery has occurred, and this rule seems to have been generally accepted. However, in *Crafoord's* case (No. II) the obstruction lasted sixty-one seconds, and in my five surviving cases, sixty, sixty-five, one hundred and four, seventy-five and one hundred and five seconds intervened before the obstruction was relieved. To these periods of mechanical obstruction must be added the ten seconds before the heart resumed sufficient action. Consequently, it would seem that under favorable conditions a complete suspension of the circulation for nearly two minutes is not necessarily incompatible with the persistence of life.

One of my latest cases, where the patient died on the table, a satisfactory action of the heart could be started even seven minutes after the patient had ceased to show signs of life, but it was not possible to reëstablish respiration.

This last observation seems to indicate that the suspension of the circulation occasions irreparable injuries to the respiratory centre in the medulla oblongata sooner than it does to the heart, and this is confirmed by similar experiences elsewhere. Thus Renzi could make the heart resume its action forty minutes after a Trendelenburg operation, although respiration could not be reëstablished in spite of artificial efforts, including the administration of oxygen. In a case of Kirschner's, reported in a personal communication to Meyer, spontaneous respiration was never reëstablished, although the heart resumed normal activity and only ceased to beat after a period of two hours of artificial respiration.

The effects of shutting off the blood-stream on the higher centres of the brain have, in the few cases where the observation has been possible, shown considerable variation. The patient operated upon and saved by Kirschner regained consciousness only after four days, and was alternately delirious and comatose during this interval. In Meyer's second case the patient showed great anguish and confusion, and vomited; however, he had

full consciousness nine hours after the operation. Kruger's patient regained consciousness about seven hours after the operation. Crafoord's first case was unconscious for several hours following the operation, cold, clammy, and for the first two days lay in a shock-like condition, at times delirious, and with complete amaurosis. On the third day her sight returned, and after this she had no cerebral symptoms. In this case, the obstruction had lasted but forty to forty-five seconds. However, when the pericardium was opened, the heart showed only an auricular flutter and no real contractions, so that evidently the complete cessation of the circulation had lasted for a longer time.

In Crafoord's second case, the cardiac ventricles at the time of the operation were making weak, irregular contractions when the rubber tube was pulled tight, and in this case the interruption of the circulation lasted for sixty-one seconds. This patient awakened while on the operating table, and showed no signs of cerebral injury during the subsequent convalescence. A similar resumption of the brain function was characterized by Meyer's first and third case and my own fourth case, with a period of obstruction lasting from sixty to one hundred and five seconds. One of my recovered patients, on whom the rubber tube had been kept taut for about two minutes, was able to reply to questions immediately after the operation, saying that he felt well, and proposed to walk back to his ward. Later, however, he had not the slightest memory of the incident from the moment of the onset of the attack till he was again in his bed some time after the operation.

The same interesting observation of complete amnesia after the onset of a severe attack of pulmonary embolism, although the patient may have seemed to be fully competent and actually suffering at that time, was made in my second case and also in cases reported upon by Kirschner and Crafoord. From the observations cited, the impression is gained that the consequences following the blocking of the circulation vary from case to case. This, however, is quite natural if it be kept in mind how many different factors play a part in the process. This disturbance of the circulation, first of all, is conditioned by the degree and duration of the embolic obstruction itself, before the embolectomy, and then by the technical strangulation of the larger vessels, necessary for the intervention, and finally, also by the obstruction of the branches of the pulmonary artery persisting after the completion of the operation. It must be remembered that even a very successful extraction may not lead to a complete cleansing of the vascular channels, while embolic masses frequently are thrust into the circulatory branches of the artery where they are out of reach of the operator. The chances of the restoration of the circulation depend also upon such factors as the age of the patient, the nature of the primary complaint, the degree of cardiac degeneration, adiposity, and the extent of the infarcts, complicating pneumonia, sepsis, *etc.*

In order to estimate the physiological effect of strangulation of the large vessels and the period during which it may last, or may be permitted under different conditions, we must have knowledge of the condition of the patient

and of the cardiac action and respiration up to the moment when they were stopped by the constriction of the tight rubber tube.

It seems fully justifiable to me to test under such favorable conditions, as a quick intervention, successful extraction of the embolus, and satisfactory physical condition, if it will not be possible to occasionally revive a patient even after he has ceased to show signs of life for several minutes. Given a good organization, it should be possible to have the artery cleared and the blood-current reëstablished within six to eight minutes.

As a rule, however, the Trendelenburg operation will be confined to those cases where the pulmonary embolism does not kill immediately, but only within the course of ten minutes, so that the operation can be regulated and planned at the right moment; that is, while the heart action and circulation have not been completely obstructed, although the certain death of the patient is imminent within a few moments.

Evidently it will be difficult always to fix the indications, as everyone with some experience knows that even very threatening conditions of pulmonary embolism may abate, and further, that the operation is so dangerous that it may completely destroy what chance there is of recovery. By limiting the indications, of course, some cases may be lost which might have been saved by operation, but, nevertheless, it is probably the wisest course to follow a moderate policy in cases of doubtful prognosis, at least until more experience has been obtained. Meanwhile, every opportunity should be developed to make it possible to attempt this operation where there seems to be a chance to accomplish anything by surgical procedure. This means that the patient to be operated upon must be ready for immediate intervention when all other chances seem to have vanished.

One should consider the advisability of completing the first part of the operation, which is time-consuming, and the exposing of the heart under local anæsthesia, which could be done with little danger, provided the wounding of the pleura is avoided, and then await the performing of the embolectomy until, if, and when, this becomes necessary, which will then require but a few minutes.

Another difficulty is that at the present time we have no definite method of diagnosing pulmonary embolism. Giertz writes in his work on thrombo-embolic surgery (Acta chirurgie scandinavia): "It is only in rare cases that one need hesitate over the diagnosis and be in danger of operating when embolism is not present." This, however, is contradicted by the experience of others, for mistakes have frequently been made. Thus, in a series collected by Capelle, the clinical diagnosis of pulmonary embolism was found to be wrong in nine cases out of twenty-six, most of these conditions having been mistaken for cardiac insufficiency. Riedel gives two cases from Denk's clinic, where cardiac insufficiency was interpreted as embolism and operation resulted in a fatal termination. I myself have operated upon one patient with uræmia who gave symptoms closely similar to those of pulmonary embolism (Case V). This patient was a man of sixty-nine who had been

admitted for prostatic adenoma and with retention of urine, and who, seven days after vasectomy, without other symptoms of thrombosis than "kletterpuls," suddenly developed an attack of dyspnœa, cyanosis, and feeble pulse, and within a short while was moribund. At the operation no thrombi were found in the pulmonary artery, the patient recovered from the operation but died after three hours in uræmia.

Pulmonary embolism may appear under various forms. The most common symptoms, when death does not ensue at once, are, shortness of breath, anguish, feeble pulse, paleness and cyanosis, and a stitch in the chest. These symptoms, however, may exhibit wide differences, both as to quality and intensity. Consequently, the condition is very changeable. In one of my cases, the most profound symptom was the feeling of constriction, like to that of a girdle around the chest, and this was associated with vomiting. In another case the attack resembled closely an acute syncope due to cardiac insufficiency or anæmia of the brain, and when the patient recovered consciousness he had no shortness of breath or pains, but an irritating cough. Within a couple of minutes the patient collapsed again, and was immediately operated upon. It is of interest to note that the pulse need not be accelerated.

Anatomical conditions and technical details of importance in the operation.*—Trendelenburg suggested that the operation be performed through an incision which would permit of the removal of the second costal cartilage and adjoining portion of the rib, thus exposing the pericardium through a widely opened left pleural space. The pericardium is incised just in front of the phrenic nerve. Renzi, when operating upon a patient shortly after Trendelenburg's report in 1908, tried to proceed extra-pleurally, but was unsuccessful and made a small hole in the pleura, which was promptly closed with pressure forceps. To Meyer is due the credit for first pointing out, in 1927, the importance of avoiding injury to the pleura and thus avoiding acute pneumothorax. The immediate dangers of pneumothorax, of course, can be reduced if the operation is done under positive intra-pleural pressure, but such pressure interferes with the pulmonary circulation. The risk of pleural infection, as shown by Kruger's first and very promising case, will be added to the already sufficiently numerous dangers. It would seem Meyer is entirely right in insisting so strongly for an operation without the opening of the pleura. The operation may succeed if the pleural cavity is opened, as has been proved by Kirschner's case in 1924, who was operated upon after the method of Trendelenburg, and my two successful cases, in which a pneumothorax resulted after lesions of the pleura. Meyer also, it seems to me, is underestimating the difficulties of avoiding injury to the pleura.

The costomediastinal sinuses of the pleura vary considerably as to position. The right one may reach far beyond the left edge of the sternum, and the left one be near the right side of the same bone. If, in order to avoid

* Beir, Braun and Kummell: Oper. lehre. 4-5. Auf. Abt. 2, p. 584, Fig. 508.

a lesion of the left pleura,* one approaches too close to the sternal edge, or even under the edge, there is a risk of opening the right pleura, which happened in one of the cases operated upon by me (Case X).

In the region where we wish to open the pericardium, below the second and third costal cartilages, the lines of reflection of the pleural sack are covered by rather firm and fatty fascia endothoracica, which are really the anterior coverings of the bed of the thymus gland, and sometimes they are separated in this place by considerable portion of the thymus itself. In one of my successful cases it was necessary to cut the thymus away from the pericardium with scissors in order to make the pericardium accessible for deliberate incision.

As a rule, it is not possible, immediately after removal of the second and third costal cartilages, to recognize the pleural sinus; one has to expose it by blunt dissection. This entails a risk of rupture of the pleura, which in this region is very like thin tissue paper. Below the second and third costal cartilage it may be so thin and fragile that the cartilage can be isolated and cut only by exceedingly careful division. In sections of old and lean individuals I have also seen the pleural sinus at a depth of several centimetres, its walls lying close to each other, the pleural lamina forming a paper-thin translucent membrane between the two pleural cavities (Fig. 1). The finding of the dividing line between

FIG. 1.—Schematic cross section of the chest wall and the anterior mediastinum. Chest wall, anterior mediastinum, pericardium and large vessels at the level of the third costal cartilage. Condition may be found in old and lean individuals.

these pleural sinuses and the blunt separation of them to expose the pericardial sac without opening one or the other of the pleural cavities may be a very delicate task. In other cases, however, the thickness and resistance of the pleural lamina and the occurrence of abundant, loose, parapleural and interpleural connective fatty tissue, together with a comparatively wide space between the two pleural sinuses serves to make the task easier.

The free portion of the pericardium, in the immediate neighborhood of the chest wall, will, however, be found below the fourth and fifth costal cartilages on the left side. The lines of reflection of the pleura at this point can be more easily distinguished than higher up, as they are not hidden by the coverings of the thymus gland, which as a rule does not reach this far down. I have suggested, in a paper read at the German Congress of Surgery, 1929, that this anatomical condition should be made use of in the operation for pulmonary embolism by the following modifications of Trendelenburg's method of uncovering the pericardium.

* Kruger's patient, 1909, survived the operation for five and one-quarter days, but died as a result of infection of the left pleural cavity.

Trendelenburg's combined incision is not necessary. Good access can be gained through a longitudinal incision along the left edge of the sternum,
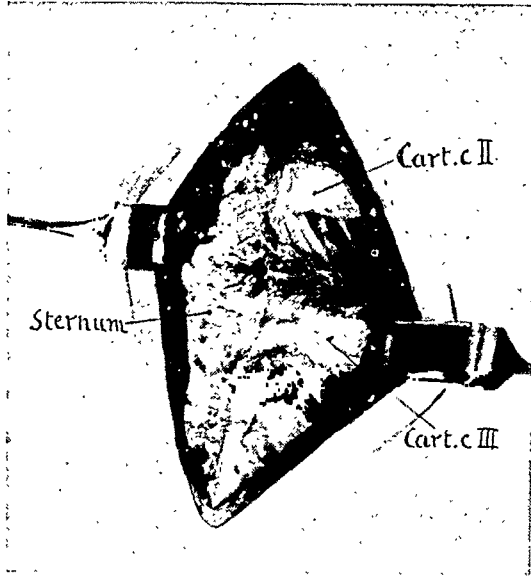
FIG. 2.—Longitudinal incision for the Trendelenburg operation.
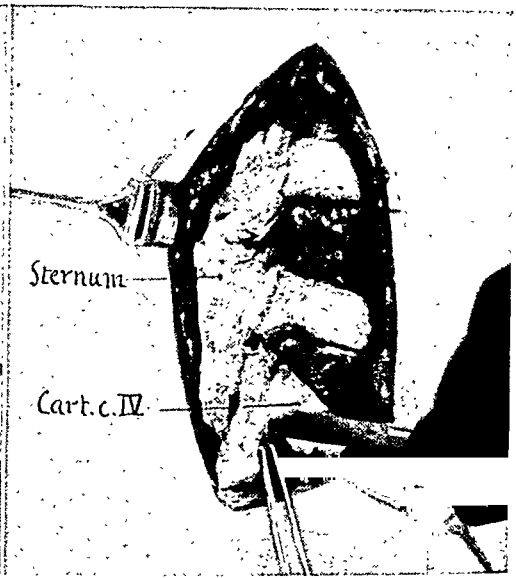
FIG. 3.—Costal cartilages freed of musculature.

extending from the upper edge of the second to the lower edge of the fourth costal cartilages (Fig. 2). The intercostal muscles attached to these cartilages are divided with the scalpel (Fig. 3) and the cartilages with the adjacent
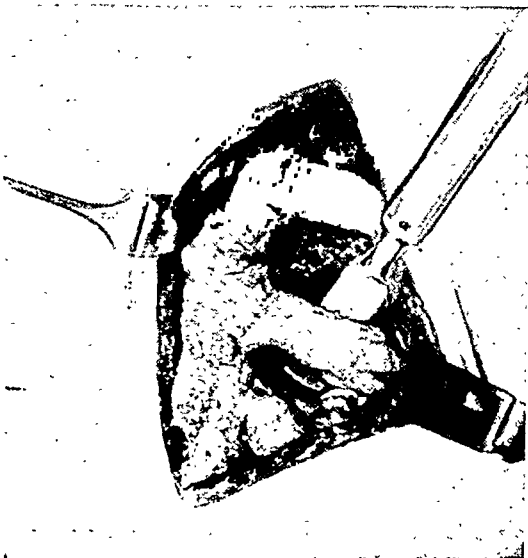
FIG. 4.—Costal cartilages and adjacent portions of the ribs isolated with periosteal elevator.

FIG. 5.—Costal cartilages cut at the sternum.

parts of the second and third ribs are then isolated subperiosteally (Fig. 4) with a raspatorium. This requires extreme care because of the risk of opening the pleural cavity. The cartilages are cut as close to the sternum as possible, even to the excision of angular portions of the edge of the

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sternum, and this should include the adjacent isolated portions of the ribs (Fig. 5). The internal mammary vessels can now be seen along the edge
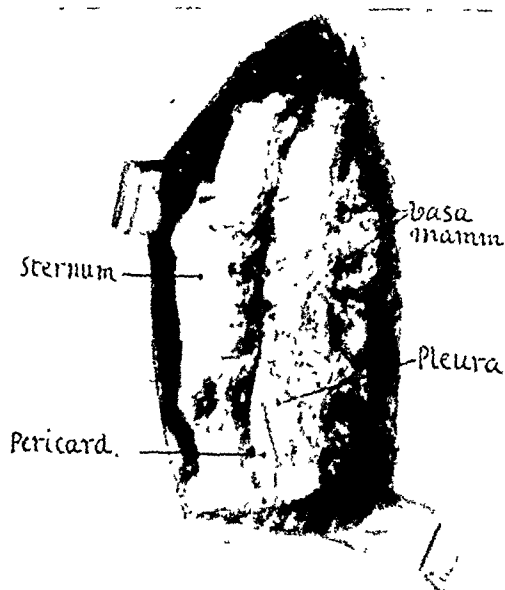
FIG. 6.—Rib resection performed. Mammary vessels exposed. Reflection line of the left pleura and the free surface of the pericardium are seen in the lower portion of the wound.
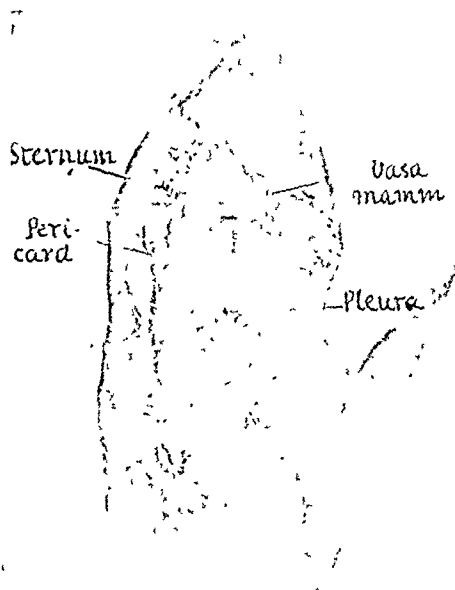
FIG 7.—Pleura pushed aside with a sweep of the finger.

of the sternum and may not need ligation. In the lower medial corner of the wound, where the fourth costal cartilage has been removed, the free surface of the pericardium can be visualized (Fig. 6). Here the finger is
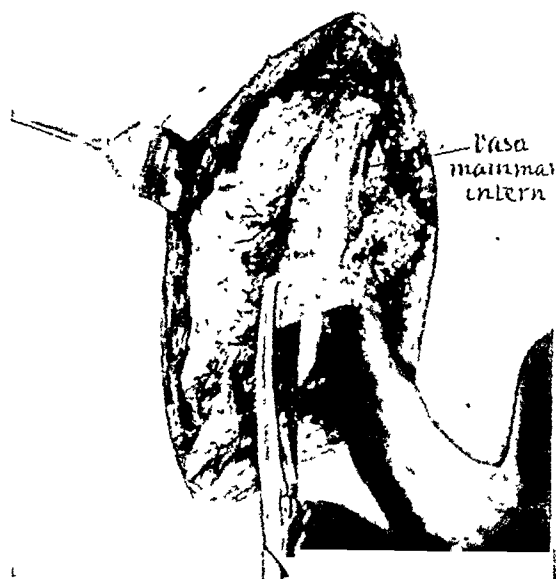
FIG. 8.—Tougher strands of connective tissue over the superficial part of the pleural sinus cut with scissors.
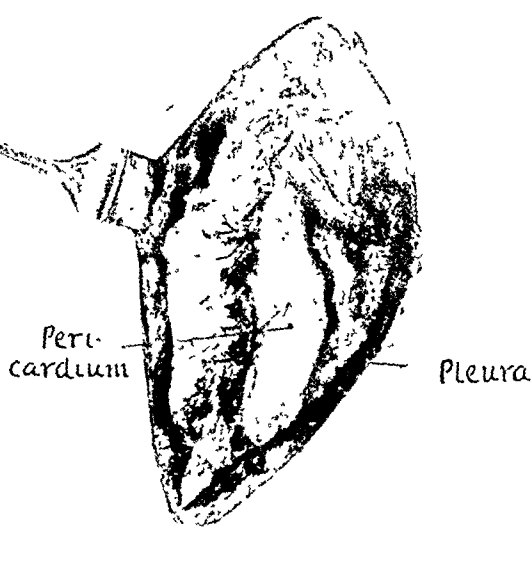
FIG. 9.—The pericardium widely exposed.

entered and moved upward in the loose tissue between the pleuræ. Frequently it is possible to move the left pleural sinus aside with one sweep of the finger (Fig. 7), but at times superficial, firm streaks of connective tissue have to be cut through with scissors (Fig. 8), while the pleura is protected

with the finger. The mammary vessels accompany the pleura. The pericardium is now sufficiently exposed (Fig. 9) and is incised in a longitudinal direction and the flaps seized with forceps (Fig. 10). It must be remembered that the pleura may be damaged also during the latter stage of the operation, as happened to Meyer in one case, and as has also happened to myself. The *slipping of a retractor may be the cause of rupture of the fragile pleura.* It, therefore, seems to me to be wise to fasten the flaps of the pericardium to the skin, or to cover the wound on both sides with gauze and to fasten the flaps of the pericardium to these pads with artery forceps or special forceps for that purpose, *e. g.,* the so-called Mikulicz forceps.

With these modifications, the operation is then carried out as suggested by Trendelenburg (Fig. 11). For the application of the rubber tube designed to constrict the large vessels, I have found that Trendelenburg's instru-
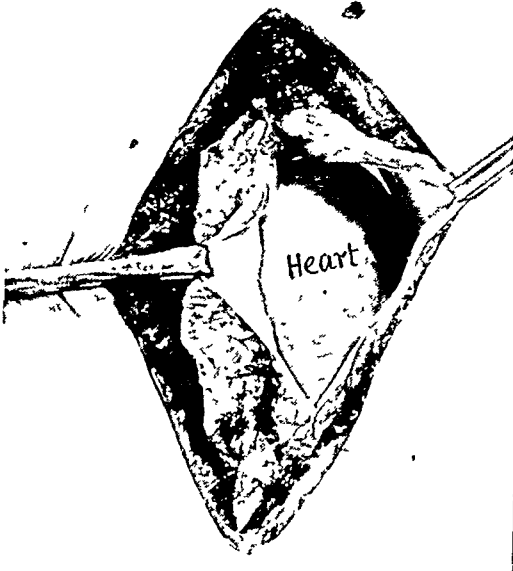
FIG 10 —The pericardium is opened
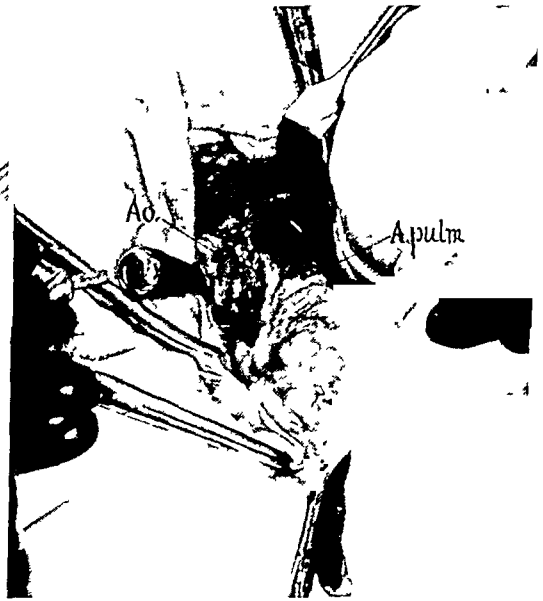
FIG 11 —The Trendelenburg probe is carried around the big vessels through the sinus pericardii The coupling of the rubber tube to it is about to be made

ment serves its purpose well, but I agree with Meyer's suggestion that another instrument with a curve of somewhat shorter radius should be available. I have modified Meyer's instrument by shortening the shank 1 5 centimetres.* The fact that the coupling in the original Trendelenburg probe is unsafe is its most serious defect. Kirschner, one of my assistants, and myself have had this coupling come undone because the rubber tube was twisted while being carried beneath the vessel, so that the bayonet catch was released. I have, therefore, had a probe constructed with a catch which will allow instantaneous coupling, besides safeguarding against the danger of detaching the tube during the operation. The rubber tube, of course, need not be released from the probe when it has once been applied; the probe can be

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* The instrument with these modifications may be obtained from Stille-Werner, of Stockholm.

placed beside the wound, and the tube unscrewed when the operation is completed.

The rubber tube should not be pulled tight until a moment after the vessel has been opened in order to allow the emboli that may be in the heart to enter the artery. If the heart has already stopped beating, or is moving only very feebly, the tightening of this rubber tube need not be strong. On the other hand, a fairly powerful pull may be necessary if the heart is still working with any force.

Too strong pressure with the rubber tube, however, may be dangerous. In one of Trendelenburg's own cases and in one operated upon by Sauerbruch, and described by Schumacher, a rupture occurred on the posterior portion of the artery and what chances there might have been of saving the patient were naturally destroyed in this way. In one of my earlier cases a rupture of the artery was undoubtedly caused by drawing the tube unnecessarily tight, but in this case the rupture was confined to the intima (Fig. 12). From these ruptures, however, a fresh wall thrombus had developed, extending into the bifurcation of the artery, and causing partial obstruction of the main branches, thus possibly contributing to the fatal issue which supervened after thirty hours.

Fig. 12.—Ruptures of the intima of the pulmonary artery (R) and the thrombus (Th.) that developed from them.

In contrast to this condition developing from the rupture of the vessel wall, the place of the suture itself was quite free from thrombus formation.

A similar observation has been made by others, where the patient has survived a sufficient length of time for the thrombus to develop. This is in contradistinction to the course in embolectomies upon the arteries of the extremities, where there is a tendency for the thrombus to develop at the site of the suture when the intima has been damaged, or where there is an associated arteriosclerosis.

If one is not closely acquainted with the anatomy of the large vessels issuing from the heart, it may happen that the aorta is opened in mistake for the pulmonary artery. In their first attempt this has happened with several surgeons, Schmidt, Capelle, one of my assistants and myself, and one other Swedish surgeon. Therefore, it is of the greatest importance to acquire a good orientation in the topographical anatomy of the large vessels by means of practice on dead bodies.

As a rule it is easy to find the right branch of the pulmonary artery, as

it passes across the operative wound in the direction of the right axilla. The left branch occasionally gives more trouble. It bends directly backward from the end of the short main stem of the artery and when the patient is in a lying position its direction is straight downward. If the incision in the artery is placed too close to the heart there is a risk of one being unable to make the extracting instrument "turn the corner" into the left branch, as happened in one of my cases. If, on the other hand, incision is made too far away from the heart, it may happen, as in another of my cases, that the extracting instrument rides past the opening of the left branch, missing it because it is too close to the incision. This happened in one of Trendelenburg's cases.

It is, of course, of the greatest importance to quickly find the way into
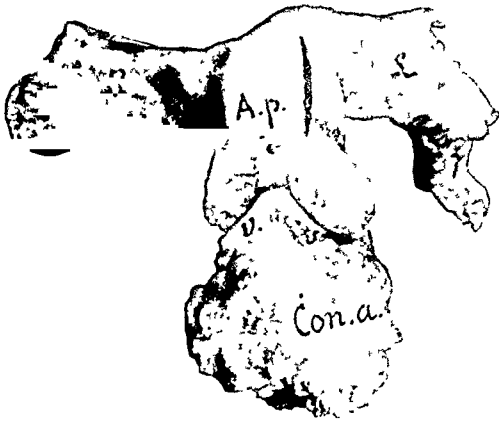
FIG. 13.—(Con. a.) The pulmonary artery (A p.) and its right (R) and left (L) branches. (vv) vales of the ostium at the root of the pulmonary artery. The proper place for the incision in the artery is marked with a black line A needle is inserted in calf vertically in the recumbent position of the body. The pulmonary artery is seen from above and in the position one sees it in the operation. The head of the needle is seen just beneath (A.p.).
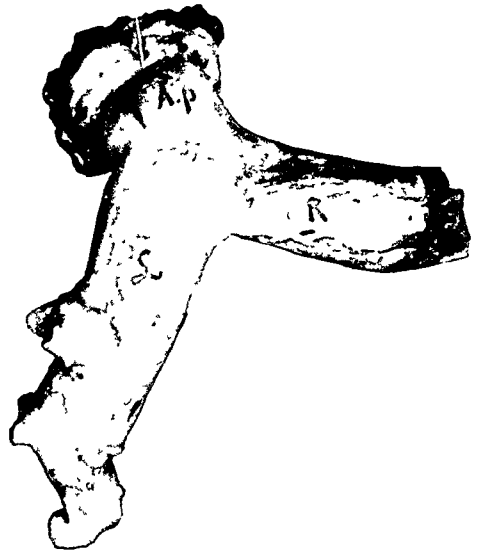
FIG. 14.—The artery seen from the cephal side.

the left main branch, so that the evacuation of the emboli can be done in the shortest possible time. I have reproduced a few pictures of stearin casts of the pulmonary artery in the position it occupies in an individual lying on his back (Figs. 13, 14 and 15). In this position the needle has been stuck vertically into the main stem of the artery, so as to allow an accurate reconstruction of the position of the artery when the cast has been removed.*

* The cast had been made by injecting melted stearin into the right ventricle from a small opening in the chest wall, from which small parts of the cartilages of the third and fourth ribs and the neighboring parts of the sternum have been removed. Naturally, the casts obtained are incomplete, as a result of the presence of blood coagulating in the artery, but nevertheless give a good picture of the typography of the artery. In the casts here reproduced, the defects are filled out with plaster, which is seen as a slight band in Fig. 13.

For the extraction of the emboli the Trendelenburg instrument (Fig. 16) on the whole serves very well. It is excellently adapted for the right branch, while for the left branch a somewhat more curved instrument would be easier to insert. Such a modification, as a matter of fact, has been suggested by Schumacker, but it has, on the other hand, been pointed out that a change of instrument would complicate the operation and might entail loss of valuable time.

Frequently the emboli are so solid that it is possible for the extraction forceps to obtain a firm hold upon them, but it is not uncommon for the embolic masses to be so fresh and loose that they offer no resistance to the forceps and, consequently, cannot be recognized. The search in such cases

Fig. 15.—The artery seen from the left side Note the bending of the left branch inferiorly (in the upright position posteriorly) and even a little caudal

has to be a blind one. The soft consistency of the emboli may also lead to their fragmentation when they are grasped by the forceps. Further, the forceps can reach the thrombi only in the stem and main branches of the artery, as space is required to open the limbs of the forceps. Probably it is through these circumstances that in many of the published operations for pulmonary embolism, great embolic masses have remained and have probably contributed to the unfortunate issue. In my Case III, the emboli were so soft that it was impossible to feel them with the forceps, and, as it happened, a large clot was left in the left branch. In this case death ensued rather suddenly, five hours after operation.

Fig. 16.—Extraction of an embolus with the Trendelenburg forceps.

The post-mortem revealed a clot which reached from the left branch into the stem and obstructed the right branch as well (Fig. 17). It is possible that it had enlarged in the direction of the heart by secondary thrombosis, or that another thrombus had lodged in front of the old one, thus suddenly making the block complete. In this particular case, however,

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the ultimate cause of death seems to have been a beginning pneumonia, which was evident at post-mortem.

These inherent difficulties of the extracting forceps forced me to experi-

FIG 17 —Embolus in the left branch of the pulmonary artery remaining after incomplete extraction

ment with a suction apparatus. The idea is not new. Trendelenburg himself in some of his experiments upon animals tried to extract the clot with a suction syringe and a wide canula, but considered the method unreliable
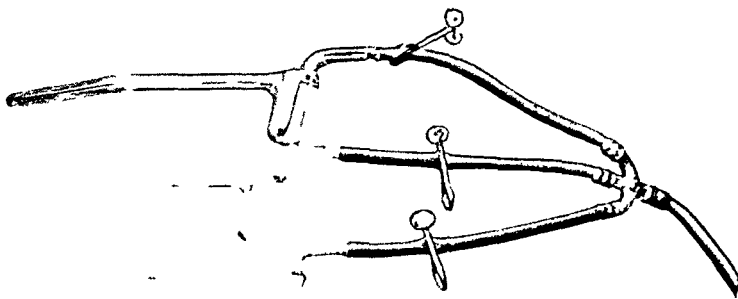
FIG 18 —Suction apparatus

and involving a risk of traumatizing the intima and, therefore, preferred the extraction with forceps. However, I argue that it would be easier to grasp even very loose and brittle emboli with a suction apparatus and that it would make possible the extraction of emboli from the peripheral parts of the arterial tree that would be inaccessible to forceps. It would be necessary,

however, that such a suction be very gentle, more so than would be possible with a syringe.

Fig. 18 shows the apparatus I have used. It consists of three pipes, each connected to a reliable water air pump by short rubber tubes, a tripartite glass tube and a common longer rubber tube. The pipes are furnished with a reservoir designed to keep the blood clots from passing the pipe, which might close the tubes. Two of the pipes are kept closed as a reserve in case the one should be put out of function by being stopped up.

In the first of my successful cases, this apparatus did very good service (Fig. 19). The forceps had first been inserted but only a few clots could be extracted with them. The suction pipe, which was then inserted, at once caught an embolus, which was thicker than and as long as one's thumb,
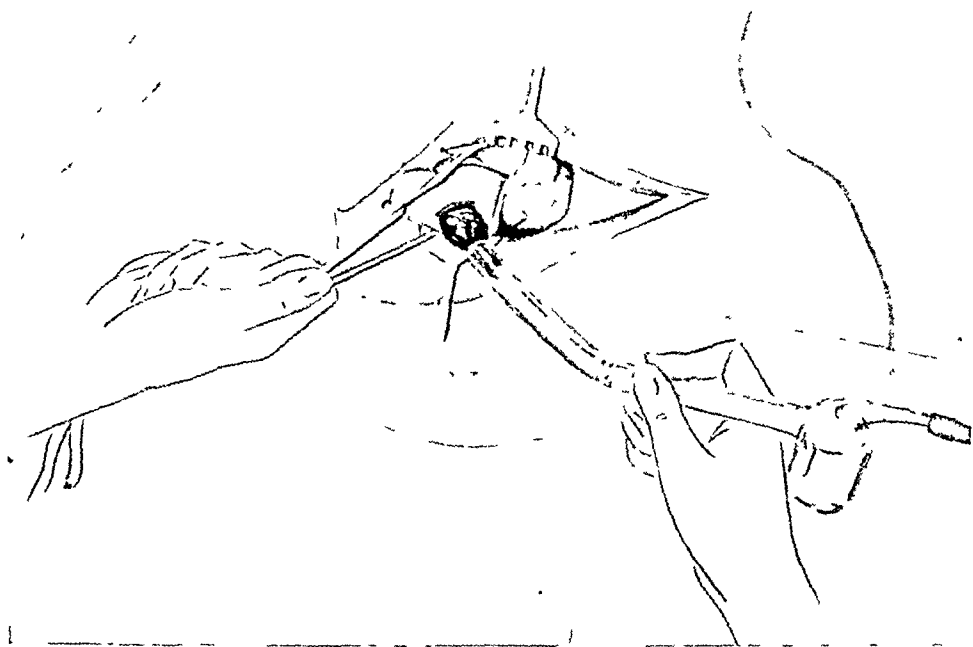
Fig 19.—Extraction of embolus with suction apparatus

which was extracted en masse (Fig. 20). It was so thick, however, that it lodged when it was half-way out of the incision, so that its delivery had to be completed with the forceps. The forceps and the suction pipe were then used alternately, but only one or two additional small emboli were found.

It has, of course, to be considered that when a suction apparatus is employed, not only emboli but also blood is sucked out of the artery, and that the blood is replaced by a large or small amount of air. When the artery has been closed and the blood-current reestablished, it might then happen that the branches of the artery were obstructed by air. Therefore, the artery should be filled with blood by releasing the tourniquet for a moment before the suture is inserted. This procedure may also serve to carry away remains of emboli, which may still be lodged in the artery. In my first successful case I forgot, in my hurry, to take this precaution, although I had decided

upon it beforehand, but, fortunately, no inconvenience seemed to follow this omission.

Trendelenburg's suggestion is that, if it is necessary to perform the extraction in several stages with intermissions in order to allow the blood to pass through the vessel, the incision in the artery may be provisionally closed with the fingers. In experiments with animals it has been shown that repeated constrictions of the large vessels are tolerated quite as well as a single one and there is something attractive in the idea that the blood should be allowed to flow through the vessels as soon as possible. Kruger used this procedure successfully in his case, operated upon in 1909. Meyer also recommends this method, and his work in Deutsche Zeitschrift fur Chirurgie, 1927, is illustrated by a fine picture. On the other hand, of course, this practice may result in fragments of the embolic masses, which would still be within reach of the extracting instrument, to be pressed into the branches of the artery, thus becoming quite inaccessible. If a considerable part of the pulmonary channel is still being blocked, this might be expected to involve difficulties with the heart that would be so great that the advantages gained by permitting a small amount of blood to pass would be more than counteracted by the injury suffered by the heart through protraction of its arrest. In any case the suggestion of suction extraction seems to me to deserve consideration and trial.

FIG. 20.—The embolic masses removed in Case IV.

The decision will depend on further experiences regarding the length of time during which, under different conditions, the large vessels may be blocked without irreparable injury to the heart and the respiratory center.

The rest of the operation is performed as advised by Trendelenburg. Meyer's modification of the forceps used for closing the incision seems to me to be an improvement, as by their aid it is not necessary to close so large a section of the vessel as with the original somewhat clumsy and too sharply bent Trendelenburg forceps (Fig. 21). The release of the rubber tube around the great vessels should perhaps be made slowly, having regard to the experiences of Vroemsten in his experiments on cats, in which he found that quick relief of a constriction of the great vessels, issuing from the heart, may cause immediate death, while a gradual reëstablishment o. the circulation is tolerated well (Figs. 22 and 23).

When the opening in the artery has been closed and the rubber tube
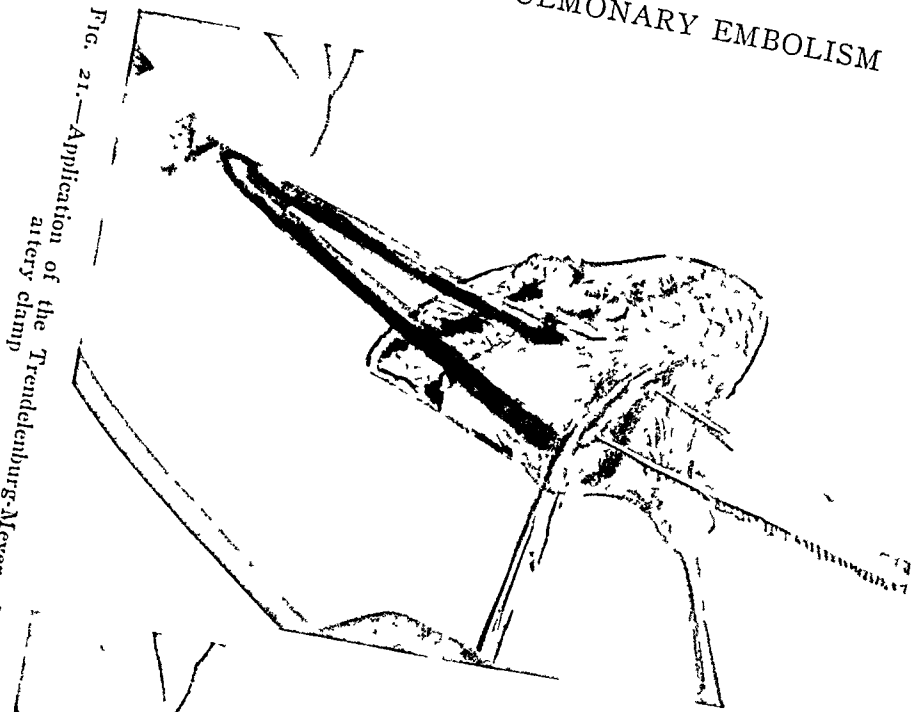
Fig. 21.—Application of the Trendelenburg-Meyer artery clamp

Fig. 22.—Suture of the wound in the pulmonary artery.
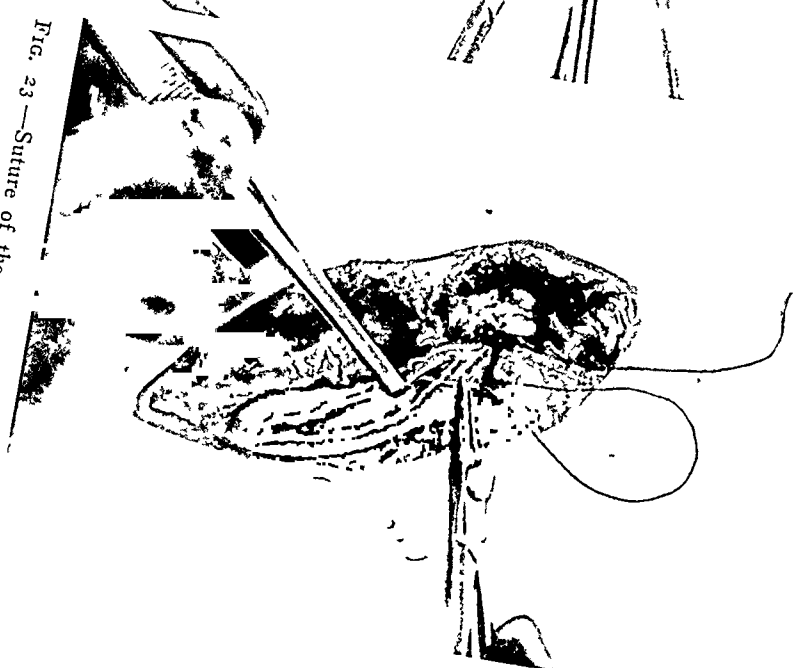
Fig. 23.—Suture of the wound in the pericardium

released, the next object is to reëstablish the action of the heart and respiration, which stop completely when the rubber tube is pulled tight if they have not already been arrested before. If the heart does not start spontaneously, mechanical irritation may first be tried. In one of my cases all that was needed was a slight push with the little finger, upon which the heart responded, at first with contractions that were hesitating and irregular and then with more and more powerful ones. Gentle, pulsating compression between the thumb and two fingers placed behind the heart may also be efficient. Schumacker in one of his cases succeeded in stimulating contractions by pressing the heart against the anterior chest wall.

In one of my latest cases, however, I found that massage may be dangerous. The patient was a fat female, sixty-nine years of age, whose heart would not start again after the extraction of emboli. After the vein was massaged, copious bleeding occurred, which was at first supposed to be caused by an incomplete closure of the incision in the pulmonary artery. Later it was found to arise in the wall of the right ventricle, where a finger had caused a small rupture in the conus arteriosus. The wall was extremely brittle, consisting of a grayish muscular layer about two millimetres in thickness, and the rest was composed entirely of fat. After death, it was found that the cardiac wall was soft and that a finger went through it as though it were made of butter. This patient, of course, should not have been operated upon.

Adrenalin injections have proven to be an excellent means of stimulating cardiac contractions. I made an injection of one centimetre of a 1 to 1000 solution of adrenalin in the bulbous arteriosis in three of my cases, and there was almost instantaneous effect. The heart, which had previously made only irregular movements, began to perform regular contraction which within a few seconds increased to almost violent force. Probably the adrenalin acts first through diffusion into the coronary artery. Crafoord in his two successful cases has also employed injections into the aorta. To me these seem to have the advantage of insuring full knowledge of the manner of the disposal of the adrenalin, and of obviating the risk of lesions to the conducting mechanism. In one of my cases where the injection in the aorta was of no avail, an injection into the heart itself was also useless.

In five of my cases, as in that of Kirschner, respiration was reëstablished as soon as the heart resumed regular action. If this should not occur, artificial respiration has to be started with rhythmical insufflation of oxygen, *e.g.,* by putting on and lifting off the mask in which a positive pressure narcosis is made or by means of a pulmotor. The inhalation of carbon dioxide may result in the reëstablishment of respiration (Dzial Oszynski). Positive pressure may also be needed if the pleura should have been damaged.

The importance of an efficient organization of the hospital, and particularly of the surgical service, to make possible the performing of an operation with the least possible delay, is self-evident. Clearly, the necessary instruments should always be sterilized. In the Uppsala Clinic the rule is, that if, on

account of suspected or evident thrombosis and signs of pulmonary obstruction of the lungs in the form of small emboli, a patient can be expected to develop embolism and thrombosis of the pulmonary artery and thus be a subject for operation, everything is put in complete order in the operating room, and the personnel of the staff warned. A transport carriage is placed beneath the patient's bed and the elevator is held at the floor where the patient lies. If the condition becomes more definite, the patient is moved to the operating room and is observed there. If further symptoms set in and the indications develop but are not considered sufficient to demand operation, the watch is continued by the surgeons themselves. Our rule is, not to operate until the patient, as far as it is humanly possible to judge, no longer has any chance of returning to life. It might, however, be worth consideration, as already pointed out, to do the preliminary part of the operation, including the exposure of the pericardium, before the condition has become too serious. The development of events could then be watched, and if the patient's condition continues to progress unfavorab'y, the operation could be completed, in which case it should be possible to empty the artery. It seems probable that in the future it may prove possible, thus to perform "in advance" under a local anæsthetic, the preparatory rib resection which, of course, requires particular care and adequate time to avoid injury to the pleura and the establishment of a pneumothorax. In this way it may be possible to call to life an occasional patient who has ceased to show signs of life for one or two minutes. Of the ten cases of Trendelenburg's operation from the Uppsala Clinic, I have myself operated upon eight, and this has been made possible by my having practically all my work within the hospital, and by living also within its grounds.

In the after-treatment there is frequently much to cause anxiety. Some of my patients who survived the intervention died with pneumonia, which, of course, is a common complication in pulmonary infarction. Pneumonia ensued in two of Meyer's, and in one of Crafoord's cases there was gangrene of the lung. In one of Schumacker's cases the patient died fifty hours after the operation with empyema of the right pleural cavity from a metastatic bronchopneumonia. In order to exclude as far as possible exogenous infection of the infarcted and infected lung, I had my latest surviving patient placed in a separate room, where nobody except the staff—and they wore masks over their mouths—was allowed to enter. In both my successful cases new threatening thromboses occurred, as also in one of Meyer's cases. In one of my cases the condition of the patient was severely affected by a hæmothorax, and was only improved in a definite way when a week after the operation venesection had been performed.

Infection of the wound naturally may occur easily, on account of the lack of time to make the preparations for the operation, and in several of the surviving cases it has endangered the result of the operation. The risk of pleural infection in connection with the opening of the pleura has already been pointed out.

Finally, new pulmonary emboli may threaten the convalescence even when rescued out of the grasp of death.

However encouraging the results may have been during the last few years with Trendelenburg's operation, it seems that only in rare cases will it be possible to save a patient otherwise condemned because of pulmonary embolism. It is upon the prevention of pulmonary thrombosis that we have to place our hopes of being able to defeat at some future time one of the most distressing complications with which, after the victories won by the introduction of antiseptics, surgery has still to wrestle.

It is of interest that the patient who has recovered from an operation for pulmonary embolism may not suffer any lasting inconvenience from the operation. Both of my patients who were cured have recently been examined

FIG. 24.—The first patient who was cured. (Case IV.) Note the Trendelenburg incision.

FIG 25.—The second patient who was cured (Case VII). Note single longitudinal incision.

and one of them, the man (Fig. 24) at the end of two years, and the other, the woman (Fig. 25) after a lapse of one year after the operation. Both are in good health. The man works as a farmer and he says he is not as persevering as before his illness and with hard work he feels palpitation of the heart, but he has no shortness of breath from climbing hills and stairways, and he works the whole day. As a result of his thrombosis the legs are swollen in the evenings, but at the time of examination there was no œdema. Beneath the weak part of the chest wall along the sternum there is a sharp systolic murmur, but nowhere else. Pulse 60, blood-pressure 160 systolic. The woman says she is as persevering as before and never is conscious of her heart. The legs are a little swollen at times as a result of the thrombosis, but at the time of examination there was no œdema. As in the former case, a sharp systolic murmur was heard under the weak part of the chest wall, but nowhere else. Pulse 74, systolic blood-pressure 140. In

both cases, X-ray examinations show no changes which can be ascribed to the embolism.

CASE I.—L. S., female, married, aged sixty-seven years. (Surgical Clinic Uppsala, 1924, A923.) Radical operation for reducible femoral hernia, November 19, 1924. November 27 there was a sudden attack of pulmonary embolism. Within a few minutes there were no signs of life. Operation was performed by Doctor Richter. At first the aorta was opened by mistake and then immediately sutured. From the pulmonary artery there was extracted a great thrombus, which filled both branches of the artery. The patient showed no signs of life during the operation and remained dead.

CASE II.—E. L. S., female, married, aged forty-eight years. (Surgical Clinic, Uppsala, 1927, No. 2263.) Rheumatoid arthritis for two months, ten or eleven years ago. Two years ago there was an operation for umbilical hernia. Eight weeks ago the patient began to complain of shortness of breath and inability to walk any distance. Slight palpitation, no swelling or œdema of the legs. The diagnosis was fatty degeneration of the heart; a reducing régime was recommended. She had hæmorrhoids for more than ten years and came to the clinic for this disability September 7, 1927.

Her general condition was not affected by the local one. The nutrition seemed to be good, the heart sounds were clear, except at the apex, where the first sounds were not quite pure, while the sounds over the rest of the precordium were dull. No arythmia, pulse 72. Operation for hæmorrhoids September 9, 1927. The hæmorrhoidal area was excised after the method of Whitehead. There was a normal convalescence except for a complaint of a stitch in the chest on September 14. On September 22 she complained of a sudden stitch below the shoulder blade which developed during the night. There was tenderness and sharp pain upon movement of the left wrist, both shoulder-joints, the ankle-joints, and less pain in the knees. There was severe shortness of breath. Objectively the lungs were negative. On September 22 her temperature was 37.2–37.6 cent., pulse 72–76.

September 23—Temperature was 37.5–38 cent., pulse 80–88.

Before this the temperature and pulse had been entirely normal following the operation.

September 25—She complained of pain in left side, no cough. Temperature still subfebrile, subsiding after a few days.

October 1—In the afternoon she developed a sudden attack, which was at first interpreted as cardiac collapse, on account of the rheumatoid arthritis. Difficulty in breathing developed rapidly, and with it a feeling as if a band had been drawn tightly about the chest; there was marked cyanosis and anxiety. Pulse was arhythmic with long pauses, but it was not rapid. Two cubic centimetres of camphorated oil were injected subcutaneously, and two cubic milligrams of pantapon. After this there was some improvement. The breathing was deeper, pulse better, cyanosis less. After some five minutes violent vomiting set in; there was still severe anguish, and an increasing cyanosis. Pulse was fairly good, of normal frequency, but arhythmic. Patient was told to breathe even, deep breaths; the vomiting ceased, her color became somewhat better, as did also her breathing. Five minutes later she was again worse. She was brought to the operating room ten minutes after the onset of this last attack.

Here everything had been made ready for embolectomy. One cubic centigram of morphia was given hypodermically. For the next ten minutes her pulse remained unchanged and then became rapid and there was a progressive deterioration, both as regards the volume of the pulse and the breathing and color of the skin. The sensorium became dim, the pulse was no longer perceptible, the face ashen-gray in color, the eyes turning up under the eyelids. There was complete loss of consciousness, and as it was

decided that death was about to take place, an operation was undertaken by Doctor Nystrom.

Under positive oxygen pressure but with no attempt at narcosis, an incision was made along the left edge of the sternum and perpendicularly to this incision an extension was made along the second rib. There was no evidence of pain while this was being done. About ten centimetres of the second rib was resected. Unfortunately, the pleural cavity was immediately opened. There was slight bleeding from the soft parts of the chest wall, but a very definite loss of blood from the internal mammary artery, which was injured, but this was controlled by the application of artery forceps.

On the left side of the pericardium there was a thick layer of fat, but the nervus phrenicus could be clearly seen. An incision of the pericardium was made in front of and parallel to the nervus phrenicus. The edges of the pericardium were seized with long forceps and kept apart. The heart still showed some pulsation. After a finger had been inserted for orientation behind the large vessels, the Trendelenburg probe was passed with ease, its point projecting to the right of the aorta; a rubber tube was then coupled to the end of the probe and drawn around the vessels. The vessels were immediately lifted and thus constricted by the tube. Thanks to a moderate distribution of fat around the big arteries localization and identification of the pulmonary artery was very easy. After the rubber tube had been drawn tight the wall of the artery was found to be collapsed, soft and yielding; this presented some difficulties in the incision of the wall of the vessel, as it did not offer sufficient resistance. An incision one and one-half centimetres long was finally made in the wall of the artery, the opening was stretched wide with the instrument indicated for the purpose, which gave an excellent support in the subsequent manipulation. The extraction forceps were then inserted. A small resistance was felt at once within the vessel and with the first grasp of the forceps an embolic mass, which seemed to have been just proximal to the bifurcation, was removed. The right branch of the artery was then entered, and blood clots totaling the size of one's finger were extracted. From the left branch, a large branched embolus, probably somewhat larger than that extracted from the right branch, was carefully extracted. In our eagerness a mistake was made in too quickly cleaning out the right branch, so that the embolus was torn, and had to be extracted in several pieces. Finally both branches were once again entered rapidly and were found to be empty. The Trendelenburg artery clamp was now applied to the vessel wall in such a way that it grasped only the edges of the incision; the rubber tube was then released, which permitted the reëstablishment of the circulation of blood within the artery. From the moment the rubber tube was pulled tight until it was released it was estimated that a period of time of one minute elapsed, and during this time the heart was absolutely still and respiration stopped. When the tube was released, a light push with the little finger was given to the heart, which immediately responded, first with a single contraction which was followed by others, while almost black blood flowed from a small opening in the incision of the artery which had not been completely closed by the clamps. The heart now made further contractions, rather weak and hesitating, but as far as could be seen, regular, and gradually gained in volume. At the same time the patient drew first a deep breath, and then began to breathe regularly, though at first with long pauses between each breath. The completion of the operation from this point was not hurried. The upper end of the internal mammary artery was ligated, in order that all clamps might be removed from the edges of the wound and make easier access for the suture of the pulmonary artery. The lower end of the artery was not found, but it did not bleed. The incision in the pulmonary artery was closed with five interrupted silk sutures. A pair of rat-toothed forceps, which had been used to draw the wall of the vessel forward when the Trendelenburg clamp was applied was then removed, and were very useful in applying the last suture. The pericardium was next sutured, leaving a gap the size of the calibre of a pea, in order to prevent compression of the heart in case some bleeding occurred from the wound in the artery. It is interesting to note

that although a small fissure remained in this wound in the artery when the clamps had been removed, the blood never spouted, but only welled forth in a steady stream as if from a large vein.

During the whole operation a positive pressure of oxygen with the Hertel apparatus was maintained in order to prevent collapse of the lung. This, however, did not expand the lung so far as to prevent from seeing the posterior surface of the pleural cavity. From the pleural cavity a few blood clots totaling the size of a child's fist were removed; the cavity was dried out with compresses saturated with rivanol solution, 1 to 1000. Finally sutures of the musculature of the chest wall were introduced. Before the last suture was drawn tight, the positive pressure was quickly increased to twenty centimetres of water pressure, which seemed to be necessary for the lung to expand (the lung tissue being rigid on account of infarction). The skin was sutured with silk.

The patient now had excellent color, was breathing regularly and had a fairly good pulse. She opened her eyes on being spoken to, while she was still on the operating table, and after a short while was able to reply to questions lucidly and clearly. She said she felt well and there was no difficulty in breathing.

The operation as a whole took about a half hour.

October 2, 3 A.M.—Since operation there has been steady improvement. Good pulse, good color, no difficulty in breathing, patient says she feels well. No cough. 1 cubic milligram of morphia, 2 cubic centimetres of camphor subcutaneously.

October 2, 10 A.M.—Temperature 40° C. Breathing somewhat more frequent. General condition fairly good.

Right lung normal breath sounds. Left lung: percussion normal anteriorly and laterally. Breath sounds are full, as far as is possible to determine, towards the axillary line, or possibly the scapular line. The breathing is vesicular anteriorly and latterly, but bronchial in character posteriorly. There is no cough.

October 2, 6 P.M.—Temperature 40.9° C. General condition still fairly good, but breathing somewhat more frequently. Slight increase in cyanosis. Morphia, camphor, sponging.

October 3—Died at 1:20 A.M., thirty hours after operation.

Post-mortem.—In the left pleural cavity 400–500 cubic centimetres of a bloody-colored fluid were found with a specific gravity of 1.047 (normal blood specific gravity 1050). There were 2,970,000 red corpuscles per cubic milligram. The polymorphonuclear leucocytes were several times as numerous as in normal blood, and there were very numerous and thick bacilli of the putrefactive type. As part of the fluid probably is exudate, it can be assumed that the patient lost at the most some 400 cubic centimetres of blood, and as the blood lost during the operation can be at the most 200 cubic centimetres, the total loss of blood would seem to have been about 600 cubic centimetres, not enough to cause death by itself, but important as a contributing circumstance. The body was markedly pale. This is evidence that hæmorrhage has to be very carefully checked, so much the more as the pleural cannot be hermetically closed, and the tendency of the lung to collapse must act as a suction pump upon the wound which is hermetically covered by the skin sutures. In this case a more energetic search for the distal stump of the internal mammary artery ought perhaps to have been made by rubbing the tissues with gauze sponge or other means. An old thrombus was found at the line of suture. There were two transverse lines of rupture of the intima of the vessel corresponding to the place where the vessel had been compressed by the rubber tube, and adhering to this line of rupture was a thick, fat thrombus, extending distally, and, as it seemed, projecting into the right main branch of the artery, although it did not completely close it. The cardiac muscle was flaccid. Hyperstasis was found in both lungs dorsally and inferiorly. Microscopical examination showed changes which must be interpreted as signs of incipient pneumonia.

CASE III.—A. S., female, married, aged forty-five years. Surgical Clinic, Uppsala, 1927 (2889). December 2, 1927.—Cholecystectomy for cholelithiasis. A normal post-operative convalescence. Patient was allowed to leave the bed and lie on couch on December 7. The next day she had a stitch in the left side of the chest and was short of breath and had a slight rise of temperature reaching 38.4° C. (day before 38.7–37.8°). She remained in bed this day and during the next few days. During the next few days the temperature gradually fell, reaching 36.8–37.8° on December 11 and 36.9° on December 12. The pulse had followed the temperature throughout and had not risen above 84 after the onset of the pain. There were no signs of thrombosis in the legs.

December 12, 1927.—In the evening (about 10 P.M.) the patient suddenly had a typical attack of pulmonary embolism, with dyspnœa, irregular and rapid pulse, and great anxiety. The severity of these symptoms, however, did not last very long and the patient recovered to some extent but was not fully conscious. After morphia and stimulation her condition remained on the whole unchanged during the night and the following day. However, a distinct deterioration set in on December 13, at 5 P.M., and in spite of stimulants the condition grew so serious that at 6:45 P.M. it was decided to perform a Trendelenburg embolectomy and we were encouraged in this by the attitude of the patient's relatives, although they had been told of the poor outlook. The temperature had now risen to 40° C., probably on account of the extensive changes in the lungs which must have been affected by the large embolus that had developed the evening before. The pulse was feeble all the afternoon, and just before operation was hardly perceptible. The physical condition was so bad that recovery seemed almost improbable even though the embolic masses could be removed.

Operation.—NYSTROM, December 13, 1927, at 7 P.M. A few drops of ether were given but when it was noticed that the unconsciousness was deep enough for an operation without narcosis this was discontinued and only oxygen was administered for a short period. A typical incision was made over the second costal cartilage and another at right angles to this incision along the left edge of the sternum. It was decided to attempt the operation without opening the pleura as sufficient time seemed to be available. As the second costal cartilage was divided a small hole was made in the pleura through which air was drawn into the pleural cavity. The opening was situated laterally and could easily be kept closed with a wet compress. The pericardium was opened. The heart made only a very few movements. The next stages of the operation followed the classical procedure of Trendelenburg. During some sixty-five seconds the blood-vessels issuing from the heart were kept shut off with the rubber tubing which was easily introduced behind the vessels. Through an incision in the pulmonary artery about two centimetres in length, embolic masses in the shape of amorphous clots were extracted. They were so soft and fragile that there was no resistance to the forceps, which consequently had to be moved at random. Both branches of the artery were cleared out, the right one twice and the left once, and it was not possible to find the way into the latter the second time. When the rubber tube had been drawn tight the heart and also the respiration stopped. When the tube had been released after closing the incision with the Trendelenburg artery clamps an injection of one cubic centimetre of a 1 to 1000 solution of adrenalin had to be given in order to make the heart resume its contractions. As the left ventricle was not visibly accessible, injection was made into the aorta at its root. This resulted in immediate contraction and a strong pulse could be felt in the radial artery. The patient was in a short time breathing deeply and well and the color of the face was improved. It was found that the pulmonary artery could be sutured with ease. About seventy-five cubic centimetres of blood had leaked out before the sutures were tight. The pericardium was completely closed by sutures and then the remaining wound in the chest wall was closed. The patient gradually regained consciousness, was able to talk, drank water eagerly and said she felt well. Four or five hours after the operation the condition on the whole was still satisfactory, but the pulse was much weaker. The temperature, however, rose higher, and at

1:15 A.M., December 14, the patient died suddenly as if the artery had been blocked by new emboli.

Post-mortem.—Examination showed that a second embolus had occurred, but it could not to a certainty be decided if the old embolism in the left branch had been added to by a secondary thrombus and these masses suddenly had blocked the right branch, or a new thrombotic mass had become loosened from the pelvic region and in the form of a new embolus had accumulated behind the remnant of the earlier one. The suture line on the inside of the pulmonary artery was absolutely even and clean, without traces of thrombosis; the intima was smooth as a mirror right up to the suture line. There were no gross minor changes in the lung, but microscopic examination revealed incipient pneumonia in the lower portion of the left lung.

CASE IV.—E. D. T., male, farmer, aged thirty-five. Surgical Clinic, Uppsala, 1928 (380). This patient had a normal post-operative convalescence following the removal of an acute gangrenous appendix and the closure of the abdominal wound without drainage. There were no subjective symptoms of thrombi in the legs, but his neighboring patient said that during the night before the third and fourth and fifth post-operative days he did have severe pains in one leg. The temperature had been normal on February 3—37.7° C.—February 4, immediately before the development of the embolism.

February 4, 1928, 3:50 P.M.—When the patient was about to leave his bed for the first time he sat up in bed and suddenly became unconscious. There was cyanosis, he was pulseless and his eyes were rolled up under the upper eyelids. With a diagnosis of pulmonary embolism he was immediately taken to the operating room, arriving there within five minutes after the onset of the symptoms. On the way to the operating room he awoke and became semiconscious. He was pale and very weak, but was unable to reply to questions and did not seem to suffer much. He even smiled while speaking. He complained of no pain in his chest and no pronounced difficulty in breathing, but there was some slight irritative cough. This rapid improvement made the diagnosis a little uncertain and the whole picture looked more like that of brain anæmia than a typical pulmonary embolism. After another minute or two he again became worse, with mental confusion, increased pallor, dilated pupils, and after this he was removed to the operating table. As all preparations for operation had been made except the disinfection of the hands of the personnel, the operator and assistant had, immediately upon entering the operating room, put on gloves and gown and were ready for immediate action. When the patient had been removed to the table he had again recovered a little, the pulse could be faintly felt, and signs of a reawakening could be noticed. After a minute or two, however, he was once again completely unconscious and pulseless.

Operation.—NYSTROM. There was no narcosis and the patient was apparently insensitive to all pain. With the usual Trendelenburg incision the second costal cartilage and the adjoining rib were removed, which was done without injuring the pleura. When the pleura was pushed aside, however, an opening the size of a pea was made in the pleura, possibly with a retractor, and this hole was closed with a catgut ligature.

Access to the pericardium was hindered by an unusually large thymus, which adhered stubbornly to the pericardium and had to be cut loose with scissors. In order to gain better access the third costal cartilage was also removed; this increase in the size of the wound greatly facilitated the operation in comparison to the previous ones, when only the second rib had been resected. The left side of the pericardium was found to be tightly stretched over the pulmonary artery, and when it was opened a few cubic centimetres of a clear yellow fluid escaped.

With Trendelenburg's instrument a rubber tube was carried around the great vessels through the sinus pericardii. The heart was beating but the contractions were weak and stopped completely when the rubber tube was drawn tight. Breathing also ceased after this procedure. An incision of about 1.5 centimetres was made in the pulmonary artery. The first excursion with the forceps was unsuccessful. The second attempt, in which the forceps were passed a little higher, found a small clot, which con-

firmed the diagnosis. A suction tube of special construction (Nystrom) coupled to a water suction apparatus, was now inserted, and by this means it was possible to pull the main mass of the thrombus halfway through the opening in the artery. The thrombus was so large that it could not be pulled entirely out of the artery with the suction tube, so that its delivery had to be completed with forceps. The forceps were then inserted into both branches of the artery and small portions of a remaining clot were extracted, then the suction tube was inserted further, first into the right, then into the left branch, and both were found to be empty and only blood was obtained. A Trendelenburg clamp was then applied to the edges of the wound in the artery and the rubber tube was removed. The large vessels had been cut off for 104 seconds, but this had allowed sufficient time to thoroughly remove the thrombi and great care had been taken to place the clamps on the wound in the artery in such a way as to facilitate its closure by suture. The heart had remained still throughout this period, but shortly after the rubber tube was released it gave the first sign of contraction. One cubic centimetre of a 1 to 1000 solution of adrenalin was then injected into the aorta at its base and in one-quarter to one-half minute later rhythmical contractions set in, first feeble, but within another quarter of a minute, stronger and more regular, rapidly increasing to almost violent power and amplitude. Breathing soon began again, the normal color of the face returned, and a good pulse could be felt at the radial artery. The wound in the artery was now sutured and the operation was completed with more deliberation. The pericardium was closed completely. The wound in the mediastinum could not be completely obliterated, although the pleura was drawn forward with catgut sutures. Muscles and skin were sutured without drainage. As the patient began to become conscious during the latter part of the operation and made uneasy motions, he was given a few drops of ether. At the end of the operation he was fully awake, was breathing easily, and asked if he could leave the table, obviously quite unconscious of what he had gone through. When he was taken to his bed, he seemed quite unconcerned, said that he had felt pain in one leg the day before, but that he had not mentioned it to the nurse, as he had thought it was unimportant, and wondered how many days more he would have to stay in bed.

During the first days following the operation the patient had a high fever, but was in good general condition. On the fifth to the seventh days there was a moderate quantity of bloody sputum. On February 10 typical pronounced symptoms of a thrombus in the right leg developed (with swelling and œdema) and on February 18 the signs of thrombosis of the left leg developed. He was discharged recovered on March 17, 1928.

CASE V.—K. G. K., male, aged sixty-nine. Surgical Clinic, Uppsala, 1928 (1048). The patient was in good health until four years ago, when he had a cerebral hæmorrhage. At this time he had difficulty in urinating with considerable frequency. During the month preceding admission there had been vomiting. There was no pain, but for at least two months he felt "out of sorts," with no appetite, very thirsty and had been drinking considerable quantities of water. He lost weight during the last six months. During the night before April 1 the patient was unwell, vomited and felt very weak. On the following day he had about ten vomiting attacks associated with diarrhœa. After arrival at the clinic April 11, 2500 cubic centimetres of residual urine was drawn off.

April 12.—Normal temperature, pulse 90, general condition fairly good. Physical examination demonstrated a typical prostatic adenoma.

April 13.—Bilateral vasectomy was performed.

April 18.—The temperature after operation was quite normal (maximum 37.51 the day after operation) but the pulse was rising, and on April 17 it was 108°. but on the morning of April 18 there was a sudden fall to 60°. In the afternoon of this day there was a rise in temperature to 38.2° C. and the patient complained of urethral pain. There were no signs of thrombosis in the legs. At 10 P.M. the patient grew rapidly worse and there was a sudden onset of pain in the chest radiating towards the back.

associated with dyspnœa and a weak, irregular pulse. Under continued observation during the following hour the pulse grew steadily weaker and the patient was moved to ·the operating room. A probable diagnosis of pulmonary embolism was made, and as the heart action grew steadily worse, the Trendelenburg operation was begun under local anæsthesia by Doctor Nystrom. Immediately after the start of the operation the pulse grew a little stronger and more regular, due probably to the effect of the adrenalin in the anæsthetic fluid. The operation was carried out along the classical lines, and when incision had been made in the pulmonary artery the forceps were inserted and no clots were found. A suction tube was then introduced, which drew only blood but found no thrombi. The wound in the pulmonary artery was kept open for seventy-five seconds, after which it was closed with silk sutures in the usual way. The heart resumed action almost immediately when the rubber tube around the large vessels was loosened and increased in power following the injection of 1 cubic centimetre of a 1 to 1000 solution of adrenalin into the bulbous arteriosis. The pericardium was closed and then the musculature of the chest wall. During the latter part of the operation the heart action was very weak and irregular, but this subsequently improved to some extent. At the completion of the operation the patient's condition was very serious, respirations were panting, pulse rapid and feeble. He died at 1:40 A.M., more than two hours after the operation upon the pulmonary artery had been finished. *Pathological diagnosis.*—Prostatic adenoma; chronic cystitis; dilatation of the bladder, bilateral hydronephrosis. No pulmonary embolism was found.

CASE VI.—A. C., female, aged fifty-nine. (Surgical Clinic, Uppsala, 1928, No. 1708). June 26, 1928, appendectomy was performed for a suppurative appendicitis and the wound closed without drainage. The temperature remained high during the first days immediately following the operation, averaging about 38.6° C., and then became subfebrile, 38° C., with a rise of 1/10 degree between July 1 and July 2, and to 38.4° on July 3. Because of the high temperature the thrombosis had been suspected for some days, and on July 3 the diagnosis was made of thrombosis of the left leg because of tenderness over the sheath of the vessel and swelling and œdema of the leg. At 8 P.M., when three nurses were lifting the patient, exercising great care with regard to the danger of an embolism, she felt a pain in her chest, accompanied by intense dyspnœa and cyanosis. She was conscious and able to speak. Recognizing the situation, not a moment was lost before she was moved to the operating room and while at first she seemed to improve a little and could breathe easier, immediate preparations were made for the operation. The symptoms were progressive and death seemed imminent, and operation was performed by Doctor Westerbron. When the operation began at 8:27 P.M. the patient replied to questioning, but the pulse was not palpable. The subperiosteal rib resection was done and the pleura was pushed aside without injuring it. The mammary artery was doubly ligated. During these procedures the condition of the patient became rapidly worse and at their completion the patient was pulseless. The pericardium was widely opened; but the pleura was not opened. The heart was found to be beating very slightly. There was some difficulty in applying the rubber tube around the roots of the artery, because the curve of the instrument was too large, and the tube, which had been put on the apparatus by an assistant, came off the apparatus at the first attempt. The incision in the pulmonary artery was about 12 millimetres in length and upon introducing the forceps several clots, some as thick as the little finger, were extracted. Upon introducing the suction tube it was immediately clogged by a clot, so that the suction was impeded and the rubber connecting tube was collapsed by the suction. Immediately after the thrombus had been removed there was fairly fresh bleeding. The opening of the pulmonary artery was closed after it was clamped with a Trendelenburg clamp. The tube was released, but at this time paralysis of the heart rapidly set in, and no contractions were evident. The vessels had been compressed for at least two minutes. Adrenalin in the right ventricle was without effect, as was also heart massage. The heart was limp as a sack, and the musculature

was so degenerated and infiltrated with fat that the external surface seemed to be composed entirely of fat. When the death of the patient was certain, the opening in the pulmonary artery was widened and a careful exploration made of its interior, and no thrombi, or at least very small ones in the minor branches, were found. Post-mortem examination was not allowed.

CASE VII.—H. C. A., female, aged forty-six. (Surg. Clin., Uppsala, 1929, No. 159). Past history was unimportant and there were no symptoms of heart disease. She was operated upon January 1, 1929, for an acute catarrhal appendicitis, and a small necrosis was found in the mucous membrane of this organ. The wound was closed by drainage and healed by first intention. On January 7 when the back support of the patient was raised somewhat, she suddenly developed symptoms of collapse, became grayish-pale in color, pupils dilated, pulse weak and low (50), but there was no cyanosis or dyspnœa. She recovered after a short time after stimulation with caffein. Slight mental confusion remained, and she had difficulty in speaking, the eyes were staring and there was a slight deviation of the tongue to the right. Reflexes were normal and there was no paralysis of the tongue. Blood pressure was 170/130. Blood urea was 33 milligrams. Upon examination of the heart its outline was difficult of recognition, the sounds were dull, but there were no signs of thrombosis in the legs. The condition was interpreted as due to weakness of the heart, or possibly cerebral embolism (foramen ovale apertum). The temperature had been subfrebrile after operation. After a steady improvement with the temperature remaining subfebrile, on January 18 she suddenly complained of a stitch and sharp pain in the right side of the chest. This was accompanied by severe dyspnœa and the appearance of rales and harsh breath sounds. There were chills and bloody, chocolate-colored sputum. This paroxysm gradually wore off, but was followed by another in about twelve hours. This time the patient was pale, had dyspnœa, but the pulse was good and the heart sounds dull with split sounds heard at the base. The lungs contained moist rales in both axillæ with occasional crackles, but there was no certainty of dullness. Temperature 38.8°–36.8°. By January 21 the temperature had gradually fallen to 37.8°–38.2°. Sputum was still blood-tinged and the general condition was not entirely satisfactory. The temperature had continued to fall and on January 23 had reached 37.7°–38° C. and this morning 37.4° C. At 9:34 A.M. there was a definite attack of pulmonary embolism. The patient suddenly became pale (no cyanosis), the pulse weak, respirations panting, eyes rolling upward, but there was no loss of consciousness. She was at once taken to the operating room and placed on the operating table within three minutes after the onset of the attack. There was no time for the operator and assistants to prepare the hands, so gloves were worn. The operative field was washed with iodine and, as the patient was still conscious, local infiltration anæsthesia was applied to the skin. At 9:44 A.M. the incision was made along the left side of the sternum and the third and fourth costal cartilages were resected together with the adjacent portions of the ribs, which was done without damage to the pleura. When an attempt was made to brush the pleura aside with the finger, however, there was a fairly wide tear of the pleura, and this was sutured as carefully as possible. Dissection down to the surface of the pericardium was then done through a longitudinal incision along the edge of the sternum, passing through the loose but tough connective tissue medially to the pleura. The pericardium was opened along the sternal edge. In order to gain space the second costal cartilage also was removed, and the wound in the pericardium was enlarged upwards. Excellent access was now obtained. (No transverse incision was made in the chest wall.) The aorta and the pulmonary artery could easily be surveyed and there was no possibility of their being mistaken. The heart still pulsated fairly strongly and in the soft-walled pulmonary artery strong pulsations could also be felt, but no obstruction, so that the diagnosis seemed doubtful. Meanwhile, the peripheral pulse of the patient had become extremely feeble and the patient was deathly pale, but still the pupils were undilated. She was no longer conscious at this stage.

OPERATION FOR PULMONARY EMBOLISM

The rubber tube was placed around the large vessels in the usual way and when all instruments had been carefully put in position, the tube was pulled tight and the pulmonary artery opened at 10:05 A.M. through an incision about 1½ centimetres in length. A stream of blood welled forth and could be stopped only by tightening the tube very firmly. The spreader forceps were inserted and then by means of the extracting forceps a small embolus was immediately removed; a few larger emboli were brought to light in one or two more grasps, and the two largest were of the thickness of one's little finger about six or seven centimetres in length. The emboli were dark red, soft, and evidently fresh emboli. Both branches of the artery were cleaned out. The suction tube was then inserted, which functioned excellently and easily entered first one branch and then the other, but obtained only blood. When the artery had been filled with blood after slightly loosening the rubber tube, the Trendlenburg clamp was applied to the edges of the incision and the rubber band was released. The artery had been constricted for 105 seconds. While the rubber tube had been tightened, the patient had been lying completely collapsed, with widely dilated pupils and without breathing. Almost instantly when the tube had been loosened, the heart, which during the constriction of the vessels had been motionless, began to beat, feeble at first, but it gradually gained strength. After the injection of 1 cubic centimetre of adrenalin in the bulbous arteriosis the contractions grew stronger and soon became almost violent and with fairly normal rhythm. After a few seconds the patient began to breathe and in a short time respirations were even and satisfactory. Soon after the heart beat had been reëstablished, the radial pulse could be felt. While she was still on the operating table she was able to reply to questions. The suturing of the pulmonary artery was now performed with ease. The clamp had not been quite accurately placed on the walls of the artery, and a rat-toothed forceps had to be temporarily applied while the clamp was being moved. At last a tight suture line was obtained. The blood remaining in the pericardium was removed with the suctions apparatus. The pericardium was sutured, leaving a small opening at the top for the escape of blood. No bleeding had occurred from the internal mammary artery, which was never seen during the operation. The wound in the thoracic wall was closed with continuous silkworm-gut suture. A thin rubber drainage tube was placed through this wound down to the pericardium. An attempt to suck the air from the pleural cavity by means of Potain's aspirator gave no results. After operation the patient was in collapse, with cold nose and legs. She complained of a severe stitch in the left side (pneumo- and hemothorax?). There was dyspnœa, which was considerably relieved by the inhalation of oxygen. Morphia and camphor were given at 2 P.M. Rectal infusion of salt solution with grape-sugar and brandy was administered. Nobody was allowed into the room without their mouths being covered with gauze masks, in order to prevent exogenous infection of the lungs. It was noticed after operation that the right leg was swollen (the right thigh measuring three centimetres and the calf two centimetres more than the left). Before the operation the patient complained of pain in the right leg. During the afternoon considerable improvement in the general condition of the patient occurred. The skin was warm, there was less pain and breathing was more normal, and oxygen was needed only occasionally. Pulse fairly good, about 120, and the temperature was 38.1° C. On January 25 she passed a comparatively quiet night. She asked for oxygen several times and evidently obtained considerable relief. There was rising temperature (38.4°–38.5°). General condition distinctly better this morning than yesterday. Skin healthier in color, she is able to speak with less effort, or at least under the effect of morphia her breathing is fairly normal, with a rate of about twenty-five per minute. There is no cough and she has been able to eat.

During the next few days the temperature remained high and there was definite dyspnœa, which was credited to a pneumonia. She was given oxygen with some relief. Five days after operation cough was present and accompanied by a red-streaked sputum. On January 31 there were chills, rise in temperature to 39.7°. There were signs of

exudate in both pleura and upon aspiration 250 cubic centimetres of a bloody fluid was obtained from the left pleura, but no bacteria could be found in the smear of it. From the right side only a few cubic centimetres of blood-tinged fluid were obtained. After this aspiration there was considerable relief. The symptoms of thrombosis in the left leg increased and on February 3 a thrombosis of the right leg manifested itself. On February 22 there was a bilateral bronchitis with a temperature of 39.6°. There was a rapid fall of temperature following this, which was the beginning of a rapid recovery. Patient was discharged practically free from fever on March 30, 1929.

CASE VIII.—S. W., female, aged thirty-eight. (Gynec. Clin., Uppsala, 1929, No. 132.) On March 6, 1929, this woman was delivered of a macerated fœtus twenty-eight centimetres in length, and apparently an intact placenta came away with the fœtus. On March 7 symptoms of thrombosis of the left leg appeared and on March 9 she showed the first signs of pulmonary embolism, *i.e.*, stitch in back, cough, and a prune-juicelike sputum. On March 10 there was a blood clot the size of a pea in the sputum. On March 20 the pain in the back had entirely vanished and her general condition was very satisfactory. The whole left leg was much enlarged. The temperature, which had been subfebrile for the first few days following the abortion, rose with the onset of the stitch in the back and March 9 to 11 there was constant fever, averaging about 39° C., with a maximum of 39.8° C. On March 14 the minimum temperature in the morning was 38.1° C. and on March 19 it was 38.8° to 39.2° C.; on March 20, 38.8°–38.8° C.; March 21, 38.6°–38.6°; and March 22, 37.6° C. On March 22 at 5:35 P.M. the patient suddenly turned pale, broke into a profuse cold sweat and complained of severe pain in the center of the chest. When the physician in charge arrived within two minutes, the patient was lying panting for breath with a weak and irregular pulse. She was fully conscious and complained that she had difficulty in getting air. She was at once brought to the surgical clinic for operation. As it was evident that the attack would lead to death, operation was undertaken immediately after a very short preparation of the hands of the surgeon and assistant. Anæsthesia was unnecessary as the patient was quite unconscious and did not react to pain. An incision was made to the left of and parallel with the sternum and five to six centimetres of the third, fourth and fifth ribs were excised, beginning at the sternum. When the third rib was resected the left pleura was damaged and the hole was at once covered with a compress. Oxygen was administered under positive pressure. Incision was then made through , the pericardium. A rubber tube was placed around the roots of the artery and at this time the patient was still breathing. When traction was made upon the rubber tubing and the pulmonary artery constricted the heart action ceased. Incision was made through the wall of the pulmonary artery and the forceps introduced through this wound, and a thrombus the size of a fingertip was extracted from the right branch of the artery, but it was impossible to find the way into the left branch. A suction tube was inserted, but no more clots were found. The hole in the pulmonary artery was closed with the Trendelenburg artery clamp, after which the rubber tubing was released. It had been drawn tight for seventy seconds. There was no heart action at this time. After an injection of a 1 to 1000 solution of adrenalin into the aorta feeble contractions of the heart occurred, chiefly confined to the right ventricle. These increased but did not quite reach normal. Respirations could not be reëstablished. Artificial respiration was given without any real result, except for some improvement in the heart action. Another injection of a 1 to 1000 solution of adrenalin was followed by no result. The heart movement decreased and ceased altogether at 6:05 P.M., in spite of heart massage. The patient during this time was pale and limp and the pupils widely dilated.

Post-mortem examination.—Thrombosis of the veins of the left leg and pelvis. Bilateral pulmonary embolism. Infarction and organization in the lower lobe of the right lung.

CASE IX.—E. E., female, aged thirty-eight. (Surg. Clin., Uppsala, 1929, No. 2665.) Patient had been in the medical wards of the surgical clinic since October 22,

1929, for a bleeding gastric ulcer. Temperature and pulse were slightly heightened during the first week, Max. 37.7° C. and pulse rate 112. There was no sign of thrombosis. For a few days before the embolic attack, incontinence of urine without any apparent cause, but the day before the attack the bladder functioned normally, and the urine was normal in character. On October 21 swelling and œdema appeared in the left leg and following this the temperature remained normal, while there was slight increase in the pulse rate, reaching 100, and the patient had a strong reaction (Ueber Guaiac) to blood in the fæces.

On November 11 at 12:10 the patient called the nurse and complained of severe stitch in the back upon moving the legs. The physician was immediately called and at 12:15 she was pale with rapid pulse, but even and full. She complained of this stitch in back, which, however, improved in a short time. At 12:20 there was another severe attack of pain with rapid and deep breathing, pulse just palpable. This attack lasted for a half minute, after which time she again felt better. There was no irritating cough, but a belching of gas. The pulse soon recovered, but was irregular, every third beat missing. Morphine injection was given and at 12:25 there was another very severe attack, after which she became unconscious and pulseless with stertorous breathing. She was immediately removed to the operating room and upon arrival she was, to all appearances, lifeless, unconscious, deadly pale, with widely dilated pupils, pulseless and with very irregular respirations.

Operation was begun by Doctor Nystrom at 12:30 P.M. The second and third cartilages on the left side were removed. There was no bleeding following this procedure and the rib resection proceeded as at a post-mortem examination. The line of reflection of the pleura below the fourth cartilage was found at once and the pleura was pushed aside with the finger and scissors from the pericardium without damage. The pericardium was opened. The right ventricle was found making a weak limp movement when it was brought into view. The rubber tube was drawn around the aorta at the pulmonary artery at 12:35 P.M., and the pulmonary artery was opened through an incision of about two centimetres in length. With Trendelenburg forceps the right branch could be entered at once and after a few attempts one or two small pieces of a thrombus were extracted. This proved the diagnosis correct. As the forceps could not get hold of any large embolic masses, the suction tube was inserted, and this at once caught hold of the end of an embolus about ten centimetres in length and about the thickness of a little finger. This was extracted in one piece and appeared like a long worm. Renewed suction with another tube obtained blood only, although the tube was inserted far into the right branch. The left branch was never found with the forceps or suction tube. The hole in the artery was temporarily closed to allow the blood to pass through the vessel. On this occasion about seven minutes had passed since the beginning of the operation and the patient had been lying with irregular breathing and was pulseless for that time. One cubic centimetre of a 1 to 1000 solution of adrenalin was then injected into the bulbous arteriosus. At first no effect could be observed, but when the heart had been massaged for a few movements it began to beat and within less than a minute made strong, regular movements. As the clamp was placed on the wound in the artery, artificial breathing was at once started by means of rhythmic compression upon the chest. This was alternated with inhalation of oxygen and the filling of the lungs with carbon dioxide in order to initiate breathing. After a minute or two the patient drew a deep breath, like the terminal breaths in dying patients which are seen for several minutes after respiration has ceased. These breaths recurred about once a minute, giving some hope that the patient might be brought back to life. Meanwhile, however, the heart action gradually failed and another injection of a 1 to 1000 solution of adrenalin was followed by a small transient effect. The last breath occurred at 12:50 P.M., when the heart action definitely ceased. The difficulty of reëstablishing respiration may have been increased by a lesion of the left pleura, caused by a retractor and resulting in pneumothorax. There now being no hope of restoring life, the pulmonary artery was

opened and by inserting the finger into the artery it was found that the entrance to the left branch, which it had not been possible to find, was just to the left of the distal end of the injection, so that the forceps and suction tube upon entering the lumen of the vessel had slipped passed it. In the left branch large embolic masses were found.

CASE X.—A. N., female, widow, aged sixty-nine. (Surg. Clin., Uppsala, 1929, No. 2830.) This patient, an obese woman, was operated upon for umbilical hernia November 13, 1929. Two days after operation there was considerable fall of the blood platelets (299,000 before operation to 234,000) but there were no signs of thrombosis. She was allowed to leave the bed with her wound healed on November 18. During the night before November 20 she developed a stitch in the chest, which was not localized, and was accompanied by difficult breathing. Her face was somewhat flushed, but there was no pronounced cyanosis. No tenderness or swelling of the legs and no abnormal physical signs were found in the lungs. She was ordered to remain in bed. During the next few days the pain vanished and on November 29 the patient felt well and still had no swelling of the legs. On November 30 while still in bed, there was sudden difficulty in breathing associated with cyanosis. The heart action weakened, many beats not reaching the radial pulse. She was at once removed to the operating room where preparations were immediately made for Trendelenburg operation. Meanwhile she grew rapidly worse, lost consciousness and respirations ceased. Operation (Nystrom) was begun immediately, only three minutes elapsing after the beginning of the attack. A longitudinal incision was made along the left edge of the sternum and the second, third, and fourth costal cartilages with their attached ribs were resected. The left pleura escaped damage, but the right pleura, which reached as far as the left edge of the sternum, was injured, as this risk had not been taken into account because of its unusual position. The pleura was very thin, about the thickness of tissue paper. The hole was closed with a hemostat, after which the pericardium was opened. The heart was found to be still, or at most making fibrillary movements. A rubber tube was passed between the roots of the great vessels and within two minutes the main branches of the pulmonary artery were emptied through an incision in the walls of the vessel. Forceps were first used but obtained only small fragments of thrombi. With a suction tube both the right and left branches were very effectively emptied. The left branch was found at once. A Trendelenburg clamp was placed upon the edges of the wound in the artery and then after light cardiac massage and injection of one cubic centimetre of a 1 to 1000 solution of adrenalin, attempts were made to reëstablish the heart beat, but in vain. The heart action was never reëstablished, nor was respiration. Insufflation of oxygen into the lungs was without effect. As blood collected in the pericardium, it was believed that the artery wound was leaking, and the forceps were removed, after the rubber tube had again been drawn tight. It was found, however, that the blood issued from a rupture in the wall of the right ventricle, which had been caused by a finger during the cardiac massage, and has passed through the wall into the conus arteriosus. This wall was exceedingly friable. Evidently the case was lost. The patient was dead and remained dead. When the hole in the wall of the heart was examined, it was found to consist of a loose, grayish, muscular layer only two millimetres in thickness, and outside of this was fat. The wall could be ruptured by a very slight pressure between two fingers.

Post-mortem examination confirmed the diagnosis of adipositas and grave chronic myocarditis. Besides this a severe arteriosclerosis, benign nephrosclerosis and cholelithiasis. The emptying of the pulmonary artery had been very complete; the right branch was quite empty of emboli, and in the left branch only a small thrombus, and another small thrombus in one of the secondary branches, but the main branch was quite free.

DISCUSSION: DR. RUDOLPH MATAS, of New Orleans, La.: said that this was a propitious moment to acknowledge the indebtedness of the profession to the Scandinavian

surgeons for their initiative and enterprise in rehabilitating the surgery of embolism and thrombosis and giving it an impetus and an encouragement that seemed scarcely possible until they infused a new life into it by their successful performance in recent years. Their collective experience has taught us the actual value and the possibilities of surgery in saving limbs and lives hopelessly condemned by embolic obstructions in the arterial system. They have set a remarkable example by their success in the heroic operation devised by Trendelenburg in 1810 for the extraction of massive obturating clots in the pulmonary artery. By their persistent and courageous efforts in this direction they have given a new cast to the Trendelenburg operation and lifted it from the plane of theory and experiment to that of actual practice, and helped to establish it as one of the most dramatic triumphs of modern surgery.

But the modern rise and development of the surgery of the thrombo-embolism in Scandinavia is nothing surprising when we consider that next to Virchow, the father of the doctrine of embolism, that it was Panum, the great Danish physiologist and pathologist, who as far back as the fifth decade of the last century enlarged Virchow's concept of thrombosis by his numerous investigations and experiments which remain as true and fundamental now as they were then. While the pathology and mechanism of *intra-vitam* clotting found its early exponents in Denmark, the surgical treatment of this disastrous complication has been especially developed in Sweden where it is cultivated with a frequency, method and faith in its value that is scarcely found elsewhere.

Of the many notable contributions to this special field of vascular surgery that have emanated from the Scandinavian countries should be mentioned the great work of G. Petrén, of Lund, who, in 1913, created an epoch in the literature of post-operative pulmonary embolism by his collective statistical research into the incidence of this formidable complication. He was the first, in 1913, to collect, analyze and classify the great mass of surgical statistics not only from the Scandinavian clinics but from all the leading surgical centres of Europe, particularly those of Germany, which had accumulated up to that time; and it was through this collective statistical survey that we have learned that the occurrence of his fatal massive form of pulmonary obstruction is not evenly distributed as a risk common to all operations, but that it is highly differentiated according to the organs or regions involved, according to the age of the patients and the diseases for which the operations are performed. He showed that an index of incidence based on the gross total number of operations was of little value statistically and that the risk of pulmonary embolism could only be evaluated approximately by classifying and comparing the incidence of this complication in the different regions, age, disease or other conditions that predispose to its occurrence. Thus the index of incidence in thyroid operations is extremely low while that for prostatectomies, hystero-myomectomies and gastric carcinoma is relatively very high.

Since 1913 Petrén's paper has served as a statistical model for all the great collective studies that have since enriched the literature of the post-operative pulmonary embolism; as, for example, the Swiss statistics of de Quervain, the serial statistics of the Mayo clinic and the great body of statistics that have been furnished by the German clinics of to-day.

But while the life-saving work of the Scandinavian surgeons in dealing with pulmonary embolism is only second to that of Germany, Scandinavian surgery is unique and is second to none in the systematic and consistent resort to embolectomy for the extraction of the embolic clots from the peripheral arteries. They rehabilitated the operation first performed by the Russian surgeon Ssbanejew, in 1895, but which for eleven years was followed, with one exception, by a succession of discouraging failures. In 1911 they took it up and now according to Einar Key's latest statistics (1929) the operation has been performed and recorded in over 216 cases, including all the great surgical arteries, of which 65 to 70 per cent. have been performed by the Scandinavian surgeons. Indeed, when this experience is compared with that of other countries it

may well be said that the operation of embolectomy has become largely a Scandinavian specialty.

But in Stockholm, Doctor Crafoord, the assistant of Doctor Giertz, in the absence of his chief made our visit particularly instructive by his personal account of the large experience of the Stockholm municipal hospital in dealing with thrombosis and pulmonary embolism as post-operative complications. Doctor Crafoord himself has to his credit two lives saved by the Trendelenburg operation. To those who are not familiar with the recent studies published by Nystrom, Giertz and Crafoord as they have appeared in the *Acta Chirurgica Scandinavia*, the experience and the hopeful attitude of the Swedish surgeons in anticipating and methodically dealing with this great post-operative emergency is nothing short of a revelation.

Prof. Einar Key, at the Maria Hospital, has personally performed seventeen embolectomies on fifteen patients for obstructing emboli in the main surgical arteries, including one embolus in the abdominal aorta at the bifurcation with recovery. Seventeen embolectomies of the abdominal aorta have been recorded in the world literature, most of them in Scandinavia, with two permanent recoveries. But in regard to the other arteries, about 50 per cent. of the patients have recovered with good circulation when the operation was performed within the first ten hours of the embolic occlusion. There are other factors besides the time interval which influence the mortality and the results, but as a whole this is a remarkably good showing for an operation which is usually performed under forbidding circumstances and which up to eighteen years ago could scarcely claim one recovery to its credit.

Doctor Giertz, of Sweden: emphasized some things that he thought to be very important. In his clinic three cases had been operated upon. In such cases he would emphasize the importance of the after treatment in the hospital. It is not enough that the surgeon himself should know the symptoms and be able to do the operation. He must train all the people who are working in the hospital, not only the young assistants but also the nurses and the student nurses and the servants, because if an accident happens, the person present in the room must know what to do. In his hospital, when an accident happens, the person in the room has to immediately take the person to the operating room and at the same time telephone to the doctor in attendance and to the nurses in the operating room. In the operating room all the things are ready for the operation. Then the doctor who is to do the operation must know all about the operation.

Another thing important to point out now is that it is wise to avoid the bad cases. We have nowadays enough healthy patients upon whom we have operated for appendicitis, hernia or done an hysterectomy and yet have lost because of an embolus. It is wise to save this operation for such patients, and not operate upon all cases with bad hearts and bad kidneys and very rigid chest cases. It is very difficult in these cases to avoid injuring the pleura.

Another thing in the technic: I am not sure it is necessary to pull the rubber tube very tight. You must remember now the aorta is quite empty and in the pulmonary artery you have the stopping blood on the other side from the plug and it doesn't matter if you lost a little blood, but I am quite sure it is dangerous to pull too tight, and it is not necessary.

Dr. Frederick T. Lord, of Massachusetts: said that in the experience at the Massachusetts General Hospital, fifty-nine patients, later coming to autopsy, have suddenly lost their lives in consequence of embolism of the pulmonary artery, one or both primary branches or their divisions. If the bad risks are eliminated, the proportion of operable cases is considerably reduced. The exclusion of those dying within ten minutes of the onset, those with inoperable malignant disease, sepsis, circulatory failure and other serious complications leaves twenty-one for consideration, and the number of operable cases is still further reduced to eighteen as the diagnosis was impossible in three. Thus only about one-third of our cases of pulmonary embolism seems suitable for possible operative interference.

OPERATION FOR PULMONARY EMBOLISM

Regarding the diagnosis, it is important to remember that the symptom-complex is not distinctive of pulmonary embolism and inevitable errors in diagnosis will in consequence occur. An appropriate symptom-complex, however, occurring after operation or delivery, the presence of thrombo-phlebitis in systemic veins or a history of pulmonary infarction go far toward establishing the nature of the disturbance. Doctor Nyström referred to the possibility of embolism of small branches and it is unfortunate from the point of view of operation that the blocking of many smaller divisions of the pulmonary arteries by numerous small emboli gives rise to a symptom-complex which cannot be differentiated from obstruction of the main stem and its large accessible branches. There are four such cases, one in about fifteen, in this series.

It is unfortunate, too, from the point of view of differential diagnosis, that there is a confusing group of other conditions with a more or less similar clinical picture. Thus, for example, alarming symptoms like those with pulmonary embolism, initiating a rapidly fatal illness, may occur in elderly persons, post-operatively or not, and at autopsy no pulmonary embolism may be found. Three such cases thought to be pulmonary embolism prior to autopsy have incidentally appeared in my review of our experience. How numerous such instances may be is difficult to determine. Sudden cardiac failure must be excluded. Previous cardiac symptoms will usually serve to differentiate this group. Coronary thrombosis may present identical manifestations. Severe and persistent pain is an important distinguishing feature, but this symptom is absent in a small proportion of such cases. Heart-block may likewise be confused with pulmonary embolism, but a slow pulse should serve to prevent mistake. An acute pneumothorax may present special difficulty in differentiation. The pathologic physiology is here much the same as with pulmonary embolism. In a person in previous good health, there may be sudden pain, suffocation and a sense of impending death, first pallor, later cyanosis, cold extremities, rapid labored respiration and poor pulse. Unconsciousness may ensue. There are five such cases in our records. One ended fatally and was thought to be pulmonary embolism until autopsy showed pneumothorax. Physical examination should, of course, readily permit the diagnosis in this group, but owing to the speed with which operation must be performed for pulmonary embolism, it is readily apparent that mistakes in diagnosis may be made.

The outlook with pulmonary embolism affecting the pulmonary artery or one or both main branches must be regarded as almost absolutely bad. Recovery, however, though rare, may follow complete plugging of one primary branch or incomplete occlusion of the main stem, as suggested by the finding at autopsy of organized thrombi in these vessels.

In attempting to formulate the indications for operation, the difficulty of diagnosis must be appreciated. It seems to me that operation should be considered in paients with a typical complex of symptoms only when this occurs after operation or delivery and with certain or probable thrombo-phlebitis of systemic veins or preceding lung infarcts, and not on patients with arteriosclerotic or hypertensive cardiac disease, with congestive failure, sepsis, inoperable malignant disease, very old persons or those with other conditions in themselves serious.

Dr. Willy Meyer, of New York, said that Professor Trendelenburg did this type of important research work in his sixties. When the speaker visited him in 1909, he was shown the calf on which Trendelenburg had done his first successful operation. They had put long narrow strips of lung tissue, removed aseptically from another animal at the slaughter house, into the deep jugular vein. Everything having been prepared for the operation, when the embolism occurred they did the operation and the animal recovered.

Then fifteen long years passed by. Many surgeons tried the operation, but not one patient recovered permanently until, fortunately, Professor Kirschner, of Koenigsberg, Germany, in 1924, had the first successful case of removal of a pulmonary embolus. Trendelenburg presented him with a set of instruments that he had devised for this

operation. They are now in the hands of the surgical division of the Lenox Hill Hospital of New York City. At that time we tried them on dogs being prepared for differential pressure. Of three dogs, transpleurally operated upon, two recovered and one developed an empyema of which he died on the twelfth day after operation.

The operation is not difficult. One easily finds with the left forefinger, introduced through the transverse sinus of the pericardium from above downward, the opening where Trendelenburg's large sound has to go through and around the pulmonary artery plus ascending aorta, the tip of the sound meeting the tip of the finger. In this way the sound comes around nicely and cannot injure any vital part. If everything develops successfully the surgeon actually recalls the patient from imminent death to life.

He recalled a remark by Doctor Giertz that the doctor who is trained in this work sleeps in the hospital at Stockholm. Our assistants also sleep in the hospital, but they are younger men. For us here it is necessary that the associates, the adjuncts and even the house surgeons be trained in this particular work, with the required instruments always ready for use, so that they can go ahead and do it in an emergency. He had not the slightest doubt that in the very near future we will hear of successful operations done in our country.

DR. HOWARD LILIENTHAL, of New York, remarked that even though in America we do not all have permanent first assistants dwelling in our hospitals, there is no reason why intensive training in this particular operation, as well as in the diagnosis, should not be given to any house surgeon who shows skill in operating. He should then be given authority to act in emergency. The head nurse should also be taught to recognize the symptoms of pulmonary thrombosis so that she can at once give the alarm and have the patient transferred to the operating room. It must be remembered that patients apparently dead have been resuscitated and have fully recovered after the extraction of emboli from the pulmonary artery.

FURTHER EXPERIENCE WITH RESECTION OF THE ANTERIOR HALF OF THE PYLORIC SPHINCTER

By John B. Deaver, M.D.

AND

Verne G. Burden, M.D.,

of Philadelphia, Pa.

One year ago we reported a group of cases, most of which were duodenal ulcers, in which resection of the anterior half of the pyloric sphincter was done. The results justified the continued use of this procedure and the experience of another year has been added. We have extended the indications of the operation to include cases of pyloric dysfunction other than that associated with peptic ulcer. The establishment of a principle in surgery must await time and experience and above all the judgment of the high court of surgical opinion. To record our experience with this operation without taint of selective advocacy and to set down the principles on which it is based, insofar as our present knowledge permits, are the purposes with which this paper is presented.

The function and mechanism of the normal stomach present many unsettled questions; the pathological physiology is virgin territory for the pioneer. The surgery of this organ has been a vast experiment much of which has been highly successful, yet the percentage of failures, the continual controversy with the advocates of medical treatment and in our own specialty the lack of unanimity of opinion regarding operative procedure, are evidence of misunderstanding and deficient fundamental knowledge.

The subject of peptic ulcer cannot be intelligently discussed without proper regard for the normal and abnormal physiology of the stomach. Since Moynihan's classic description of its symptomatology, peptic ulcer is now readily detected. Also, we have come to know that the typical symptoms may be present even in the absence of ulcer owing to the gastric mimicry when the disease is in the appendix or gall-bladder and even in the exploratory absence of abdominal disease. From autopsy reports we know that frequently ulcers have existed without symptoms. Therefore, it seems logical to assume that the ulcer itself is not the cause of the typical symptom-complex but that the latter may occur independently of ulcer and actually expresses a derangement of gastric function and mechanism of which ulcer may be a sequel. The frequency with which ulcer recurs after any type of operation is an indication of a basic disturbance of gastric physiology.

The most essential factor in the causation and chronicity of ulcer is probably acidity. The rôle of infection from foci within and outside the abdomen may have to do with the origin of the initial lesion in the way of preparing the soil for the destructive action of acid. The main stimulus for

the secretion of gastric juice is the presence of food in the stomach. The stimuli which have to do with the appetite and taste reach the stomach by way of the vagus nerves. Section of these nerves within the thorax is followed by a permanent reduction in gastric acidity. Under normal conditions the stomach probably secretes very little acid in excess of digestive requirements. The newly formed acid has a uniform concentration of about 0.5 per cent. In the absence of excessive secretion the ingested food and liquids and the diluents secreted by the stomach act to reduce the concentration of acid to about 0.2 per cent., which is the optimal for digestion. By the time the contents leave the stomach the acidity of the ejected portion is so low that it is not injurious to the duodenum and is promptly neutralized. There are many conditions which cause a temporary over-production of acid in the stomach; common examples are indiscretions of eating and drinking. It is well known that in such instances there is regurgitation into the stomach of duodenal contents composed of duodenal secretion, bile and pancreatic juice which make up a highly alkaline mixture. The purpose of this regurgitation is, in all probability, to control excessive acidity in the stomach. Stimuli resulting in hypersecretion and over-production of acid reaching the stomach by way of the vagus nerves may originate in a disturbance of the higher nerve centers. This is commonly called nervous indigestion and nervous hyperchlorhydria. In such instances there is usually an associated disturbance of the pyloric sphincter—either failure to relax or actual spasm. The symptoms closely simulate ulcer and, indeed, in long-standing cases, ulcer is actually present. It is well known that peptic ulcer occurs most frequently in individuals of a characteristic nervous temperament which is essentially a constitutional type and not an acquired condition as a result of the ulcer. Is it probable that the hyperacidity in cases of peptic ulcer is due to excessive production of acid resulting from exaggeration of the psychic phase of secretion? When this characteristic is in marked evidence there is likely to be a recurrence of ulceration after operation. Given the conditions in which there is long-continued gastric hypersecretion and over-production of acid and an associated disturbance of pyloric function which acts as a hindrance to the safety mechanism of duodenal regurgitation and neutralization, there will ensue a state of chronic hyperchlorhydria with over-active gastric peristalsis to force the pyloric block. The strongly acid gastric contents are ejected through the pylorus under increased pressure and impinge against the duodenal mucous membrane usually at a point which corresponds to the location of 90 per cent. of ulcers.

It has been established by experiment that peritoneal irritation is a cause of spasm of the pylorus and by clinical experience that it is often accompanied by gastric hypersecretion and hyperacidity—conditions which are favorable for the development of peptic ulcer. Herein may lie the explanation of the frequent association of disease of the appendix or gall-bladder and peptic ulcer, also a plausible reason for post-operative recurrence of ulcer when a diseased appendix or gall-bladder has not been removed.

The ideal treatment for peptic ulcer is the removal of the cause which has to do with its chronicity. This we believe to be an over-production of acid combined with failure of the control mechanism by reason of dysfunction of the pyloric sphincter and its interference with regurgitation of alkaline fluid from the duodenum. Removal of the psychic phase of gastric secretion by section of the vagus nerves within the thorax would seem to be an effective method of controlling hyperacidity. But the physiologic consequences of this procedure on the other abdominal viscera might prove to be forbidding contraindications. In the absence of this fundamental disturbance, experimentally produced ulcers promptly heal. Clinical peptic ulcers undergo partial healing during periods of symptomatic remission and again become active when the causative gastric derangement reappears. The basis of all treatment, medical or surgical, is essentially the control of acidity. If this assumption is correct, efficient medical therapy would necessitate a knowledge of the amount of alkali required for the control of acidity and this quantity would probably vary from day to day depending upon fluctuations in the acidity. Furthermore, the treatment would have to be continued not only until the ulcer has healed but until its causative factors have disappeared, and this may be a matter of years. There is reliable clinical evidence that some peptic ulcers heal under medical management and that others heal without any form of treatment. While in a small percentage of cases there has been a permanent cure, the greater number suffer a recurrence when treatment is interrupted. Many surgeons have seen cases of acute perforation occur while under medical treatment. Cases of peptic ulcer with a short history are claimed by internists and many surgeons to be proper subjects for medical treatment. It is probably true that in many of these cases there is a temporary ulcer diathesis which is amenable to medical control and is unlikely to recur. Of this there is no certain knowledge. The hazards of perforation, hæmorrhage and deformity remain. We have seen many cases of acute perforation where the antecedent history of ulcer has been only of a few days' duration or entirely absent.

Operations for peptic ulcer may be grouped into two main divisions: those which are done for more efficient neutralization of acid (of these gastroenterostomy has been the most successful) and those whose purpose is to eliminate, completely or partially, the formation of acid by resection of the stomach. Gastroenterostomy has made its reputation principally in cases where there has been organic obstruction at the pylorus. It has not been so highly successful in cases of early ulcer without pyloric obstruction, and in these instances it is possible that the causative factors of ulcer have undergone spontaneous correction and left the patient with an unnecessary gastroenterostomy which Moynihan states is a reason for failure of the operation. Is this an example of the fact that gastroenterostomy may be a disease? Gastrojejunal ulcer occurs with disturbing frequency. We advance the theory that its cause is essentially that of the original ulcer—uncontrolled acidity. The alkaline current in the proximal segment may

sweep past the anastomotic stoma without entering the stomach. In such an event the hyperacid gastric contents come in contact with the margins of the stoma and with the jejunal mucous membrane and ulcer develops as it did on the original site in the duodenum or the stomach.

Resection of the stomach for peptic ulcer is an heroic attempt to control acidity. It is claimed for this operation that it removes the ulcer-bearing area of the stomach and duodenum, and that it inhibits or abolishes the secretion or acid by excision of the specific acid cells. Sufficient time has elapsed for it to be known that neither one of the former assumptions is correct, because of the frequency of secondary ulceration after this operation which certainly merits serious consideration. Removal of the entire acid-forming portion of the stomach is a difficult and uncertain procedure. In many cases it is probable that sufficient acid-forming mucosa remains to produce a secretion capable of initiating a new ulcer at the stoma or in the jejunum. We have long felt that gastric surgery for benign lesions should strive for the simplicity in procedure and the least distortion of normal anatomical relationships consistent with results which justify the attempt. The theory which ascribes to acid the predominant rôle in the causation and chronicity of peptic ulcer derives its strongest support from clinical experience and recent experimental studies. It is a theory upon which surgeons and internists are in fairly general agreement. It is unlikely that the normal behavior of gastric acidity could be a factor for evil in the development of peptic ulcer. There are normal fluctuations in acidity and even temporary excesses for which the mechanism of duodenal regurgitation provides a safety control. Otherwise, acid of injurious concentration would exert its destructive effect by causing ulceration of the mucosa with which it comes in contact. Therefore, the origin of ulcer would seem to be in the combination of the two factors—over-production of acid and failure of the safety control of duodenal regurgitation. The unknown urge which causes an excessive formation of acid may be a fundamental nervous derangement which may also act to hinder duodenal regurgitation by causing dysfunction of the pyloric sphincter. In the absence of any means of direct attack to check the over-production of acid, concerted efforts by medical and surgical methods have been made partially to neutralize the high acidity. It seems logical to assume that restoration of duodenal regurgitation may be a solution of the problem, especially since it has been shown that this phenomenon is absent in clinical cases of peptic ulcer. It is with this purpose in mind that we have carried out excision of the anterior half of the pyloric sphincter and thereby removed the hindrance to duodenal regurgitation.

The technic of the operation is simple, with little chance of serious error. It is undisturbing to anatomic relationships and relatively free from immediate or remote post-operative complications. Essentially it is a subserous removal of the anterior half of the pyloric sphincter without penetration of the submucosa or lumen of the duodenum or the stomach. A continuous suture of the serosa closes the remaining defect.

Contraindications to the operation are inaccessibility of the pylorus and the presence of excessive scar tissue in the region of the sphincter.

The chief danger of the operation is an unrecognized accidental penetration of the duodenum which may result in the formation of a fistula.

X-ray studies, made months after the operation, have shown that the action of the pyloric sphincter has been mostly abolished. In cases where there had been gastric retention with evidence of pylorospasm and hyperperistalsis there were now normal peristalsis, no sign of pylorospasm and the stomach emptied in normal time. The operation did not cause an appreciable narrowing of the pyloro-duodenal canal although in a few instances the X-ray detected a slight deformity in this region.

Our cases are too recent to permit an adjudgment of final results, but in the two years of experience with the operation there has been no occasion to re-operate for persistent symptoms of ulcer, and most of our patients report regularly for examination in the Follow-up Clinic. Should the occasion arise, a gastroenterostomy can readily be done.

We believe that the operation of removal of the anterior half of the pyloric sphincter will be as successful as any procedure now used for peptic ulcer. We expect to have some failures, but in these cases the secondary condition will not be so serious as the complications of gastroenterostomy and resection of the stomach.

In our early experience we limited the operation to cases of peptic ulcer. Later on, we applied it to cases of pylorospasm associated with disease of the appendix or of the gall-bladder or hyperchlorhydria alone, using it as an adjunct to the operation for the primary condition with the hope of eliminating post-operative digestive complaints.

Report on Operations in which the Anterior Half of the Pyloric Sphincter Was Removed

Eighty-one cases have been operated on since October 6, 1927.

Duodenal ulcer.—There were forty-two cases. In a number of these cases to be noted, the ulcer was excised in addition to removing one-half of the sphincter. There were five cases of acute perforation and one of chronic perforation. Appendectomy was done in all cases when the appendix had not been previously removed. The procedures in the 42 cases of ulcer were as follows:

Operation on the sphincter alone .... 14 cases
Operation on the sphincter and cholecystectomy .... 11 cases
Operation on the sphincter and excision of the ulcer .... 9 cases
Operation on the sphincter, excision of the ulcer and cholecystectomy .... 7 cases
Operation on the sphincter, gastroenterostomy and cholecystectomy .... 1 case

Gastric ulcer.—There were nine cases of gastric ulcer, one of which was an acute perforation. The procedures were as follows:

Operation on the sphincter, excision of the ulcer and cholecys-
    tectomy .... 1 case
Operation on the sphincter and excision of the ulcer .... 4 cases
Operation ,on the sphincter, sleeve resection of the stomach and
    cholecystectomy .... 1 case
Operation on the sphincter and sleeve resection of the stomach.... 3 cases

Gall-bladder.—There were twenty-three patients who were operated on for disease of the gall-bladder and biliary tract and in whom, in addition to the indicated operation in this region, the anterior half of the pyloric sphincter was excised because of spasm. In the above group one patient had a stone removed from the common duct; one had drainage of the common duct because of biliary cirrhosis; one, in whom the gall-bladder and the common duct had been drained previously, had a secondary drainage of the duct with a T-tube; one patient had a carcinoma of the pancreas and had a cholecystogastrostomy—this patient died five months later—one patient had a cholecystostomy.

Chronic appendicitis with reflex gastric symptoms.—There were six patients in this group. Appendectomy and removal of an anterior half of the pyloric sphincter was done.

Gastrojejunal ulcer.—One patient was operated on for this condition. Three years previously he had had a duodenal ulcer excised and a gastro-enterostomy made. At the second operation, at which time the gastrojejunal ulcer was found, the jejunum and the associated ulcer were resected and the bowel joined by end-to-end anastomosis and the anterior half of the pyloric sphincter removed. Nine months later the patient had recurrence of a duodenal ulcer and was again operated on, at which time a gastroduodenos-tomy was made. Four months following the last operation he reported that he was completely relieved of his symptoms through dysfunction of the pyloric sphincter.

SUMMARY

A corrective procedure which removes the pyloric interference with duodenal regurgitation has been applied in clinical cases of peptic ulcer, pyloro-spasm and hyperchlorhydria. In this procedure the anterior half of the pyloric sphincter is removed. In an experience with eighty-one cases over a period of two and one-half years, the results have been at least as satisfactory as from any operation we have used in similar cases insofar as symptomatic relief and post-operative X-ray findings are concerned. We have not yet encountered a recurrence of ulceration and, of course, the development of gastrojejunal ulcer is impossible. The removal of the anterior half of the pyloric sphincter is a much simpler operation than gastroenterostomy or resection of the stomach, yet the results are equally satisfactory and the post-operative complications and late sequelæ are much less hazardous.

CONCLUSIONS

The probable cause of peptic ulcer is uncontrolled hyperacidity which is brought about by excessive secretion of acid (probably by exaggeration of

the psychic secretion) and failure of the control mechanism of duodenal regurgitation.

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CARCINOMA OF STOMACH WITHOUT RECURRENCE TWENTY-FOUR YEARS AFTER OPERATION

By Arnold Schwyzer, M.D.

OF ST. PAUL, MINN.

Four years ago, while giving a clinic on Surgery of the Stomach at a meeting of the Minnesota Medical Society,* I could show three healthy and happy old men who had cures lasting more than ten years after resection
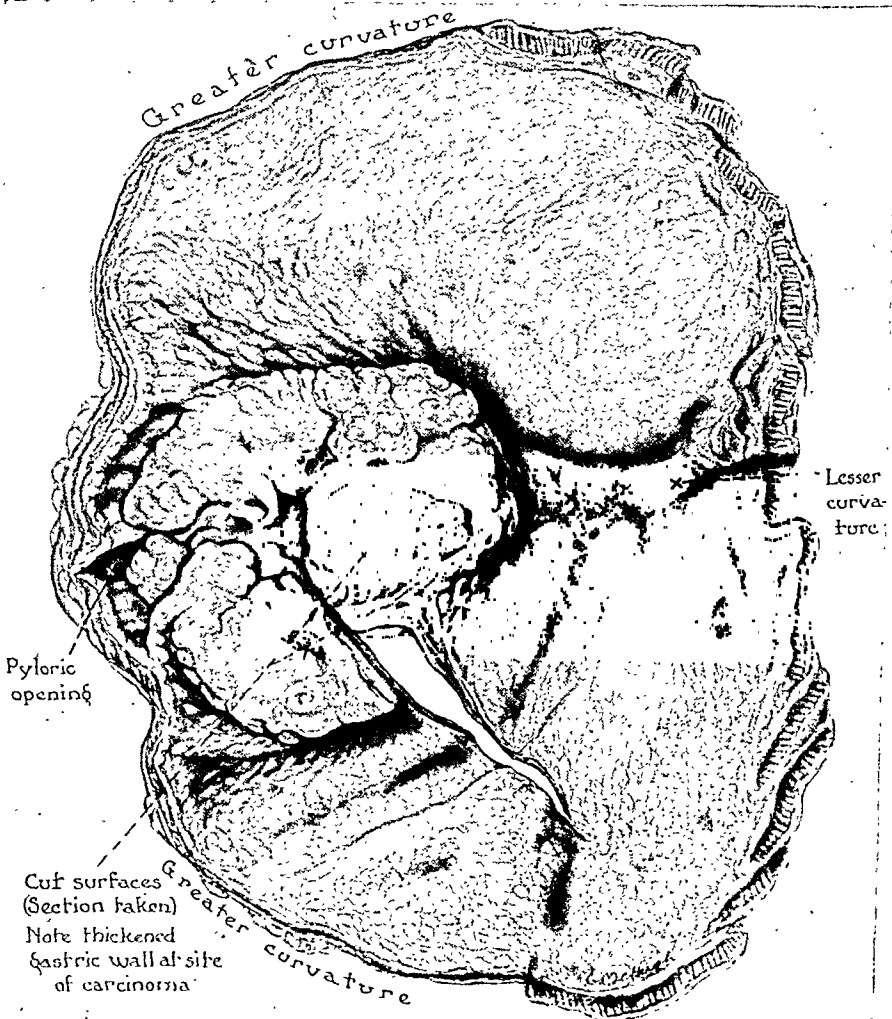
FIG. 1.—Mr. H. Sch. specimen removed at operation, cut open along greater curvature. Drawing.

of the stomach for carinoma. None of them had been early cases and the resections were extensive. The outstanding feature was the absence of wide-spread lymphatic involvement. In fact, only the lymph-nodes in direct proximity of the growths were invaded. One of these patients, Mr. F. L. V., sixty years old, was operated upon in September, 1915, at St. Joseph's

* Published in Minnesota Medicine, February, 1927.
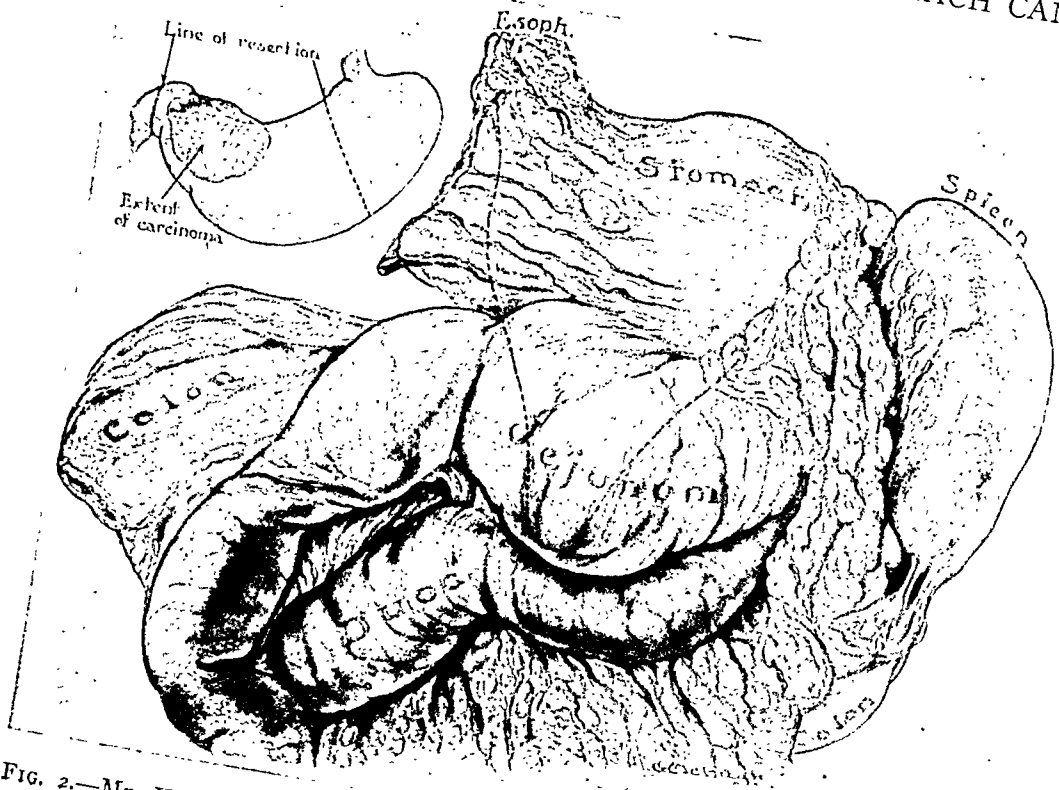
FIG. 2.—Mr. H. Sch. Drawing of autopsy specimen. Stomach is size of fist; afferent and efferent loops of jejunum dilated; ante-colic gastro-jejunostomy.
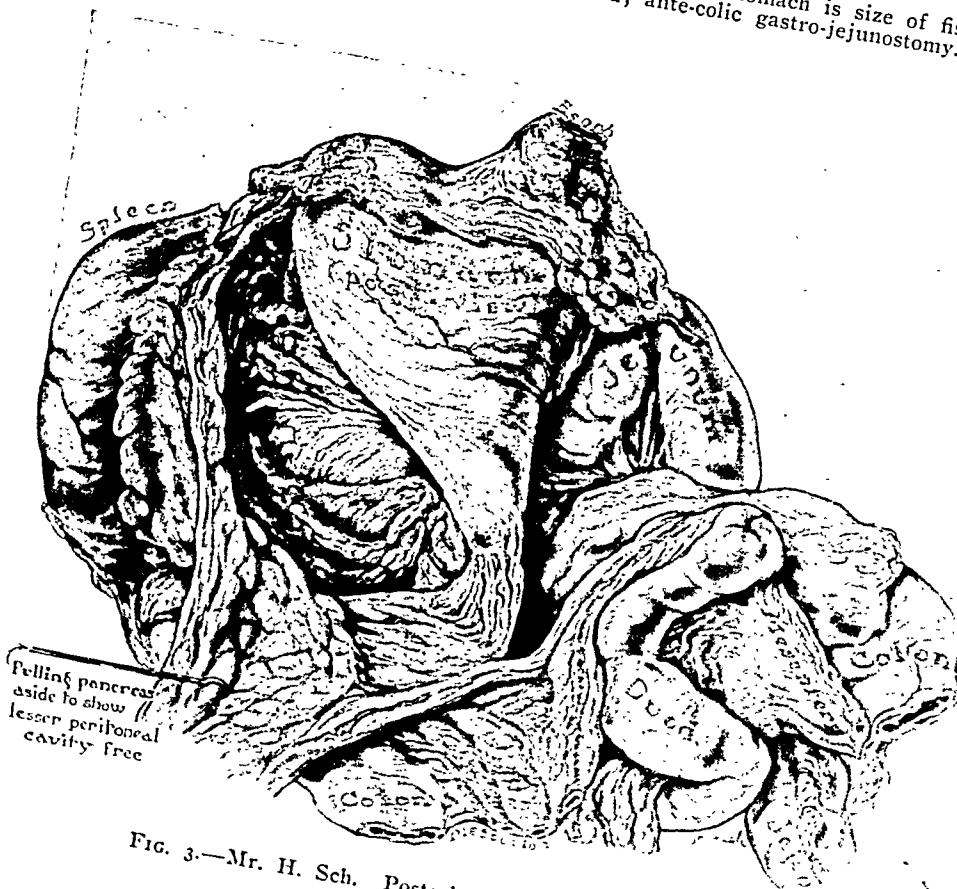
FIG. 3.—Mr. H. Sch. Posterior view of autopsy specimen.

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Hospital. A small piece of liver and some pancreas tissue had to be taken away with the carcinoma of the lesser curvature and posterior wall of the stomach. The tumor was partly adeno-carcinoma, partly carcinoma solidum. This man is well today, fourteen years and eight months after the operation. The second case, Mr. J. B., was sixty-six years old at the time of his operation, which was in April, 1915. He was reported by his son these very days to feel quite well. It is now fifteen years and one month since the operation. The growth in his case was a carcinoma solidum. The microscopic appearance of the tumor, whether of the glandular or solid type, did not seem to have much bearing on the prognosis. The first-mentioned case was partly a glandular and partly a solid carcinoma; the second a carcinoma simplex, while the third patient, who is the cause of this report, had a carcinoma of the purely glandular type. The microscopic findings were
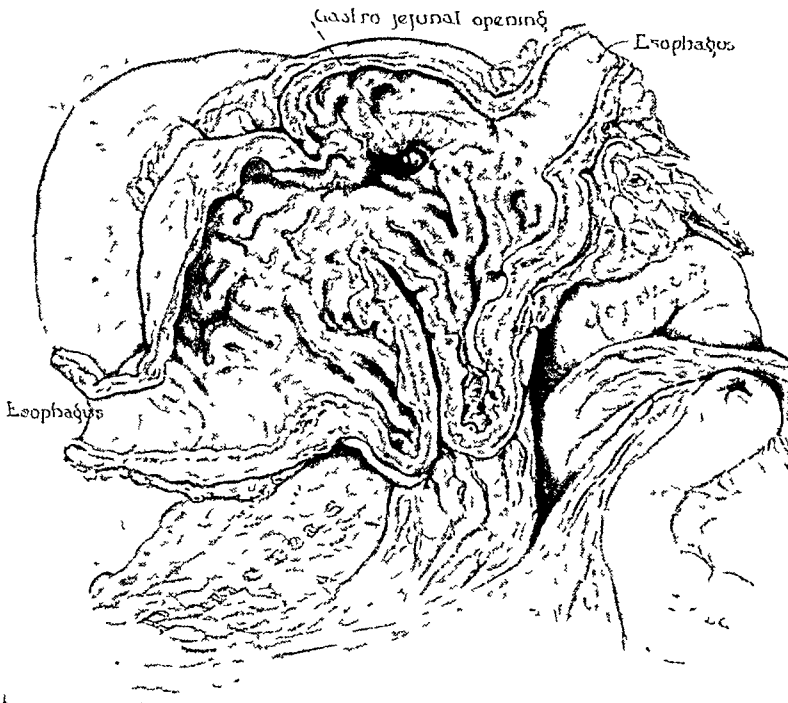
FIG 4 —Mr. H. Sch   Posterior view   Stomach cut open and divided in half   Posterior half turned down

verified by Professor Bell, chief of the Pathological Department of the University of Minnesota.

The third case is as follows: Mr. H. Sch. was operated upon in February, 1905, at St. Joseph's Hospital. He was then sixty years old. He died February, 1929, of apoplexy which occurred after the celebration of his eighty-fourth birthday.

Since summer, 1904, he had suffered from pain in his stomach and loss of appetite. His weight had come down from 140 to 109 pounds. The carcinoma involved the lesser curvature near the pyloric area, and was the size of a woman's fist. An extensive resection was done a good distance from the tumor. On the proximal side there were full two inches of apparently normal stomach wall on the removed specimen. This was one of the deciding features for the freedom from recurrence. Examination of the specimen revealed that the tumor mass protruded greatly into the lumen of the stomach and seemed very well outlined. The bordering normal-looking stomach wall showed, however, on its cross-section, some barely

noticeable thickening, which gradually diminished toward the outer regions. Microscopically, it was found, outward from the macroscopic tumor, that the carcinoma extended for two centimetres in the mucosa. The secreting glands were much larger than normal and of irregular shape. There were no metastases in lymph-nodes, beyond invasion by contact in the area of the growth itself. Sections from discrete pyloric and cardiac lymph-nodes as found on the resected specimen showed no metastases, though they were somewhat large, probably on account of a partial ulceration of the tumor. This patient, who left the hospital after twelve days, rapidly gained from 109 pounds, in four months, to 133 pounds, and even reached the weight of 147 pounds, in 1909, four years after the operation. Later, the weight gradually came down again and since the old gentleman approached four-score, the weight, gradually and perhaps fortunately, ranged in the neighborhood of 110 pounds. In the summer of 1927 he had some diarrhœa and loss of appetite, but this blew over quickly. There was no food distress. He

FIG. 5.—Mr. H. Sch. Photomicrogram of tumor.

FIG. 6.—Mr. F. L. V. Partly glandular and partly solid carcinoma; shown for comparison. Cure lasting fourteen years and ten months.

ate of everything that came on the family table, but, since the operation, had to eat slowly. The apoplexy which caused his death was evidently due to the excitement of the birthday party.

The autopsy had to be limited to the abdomen. There was no trace of any recurrence anywhere—no glandular thickening. The lowest portion of the œsophagus was dissected out and was removed in one piece with the remnant of the stomach, the spleen, the pancreas and adjoining small and large gut. The artist of the Department of Pathology of the University of Minnesota then made drawings from front and from the posterior side. The inset gives as near as one could measure the proportions of the resection. After tying off the jejunum the specimen was filled with formalin through a tube tied into the œsophagus. This allowed it to harden in more natural relations. Later the stomach was cut open from the œsophagus down along the greater and lesser curvatures leaving uncut only a small area at the greater curvature. There were no disturbing adhesions either in front

or behind where the lesser peritoneal cavity was entirely free. The only variation of the drawing from the specimen was the upper end of the duodenum, which had been cut in removing the organs.

At the time of the operation we had judged to have removed about two-thirds of the stomach. If this was correct the remainder must have shrunk considerably, even if one allows freely for the infolding suture. The stomach wound had been closed and an anterior gastroenterostomy with an entero-anastomosis between the two limbs of the jejunal loop had been done.

The remnant of the stomach was about the size of a goose egg. The gastroenterostomy opening was just large enough to allow entering of the index finger. It was clean-cut, patent and round though at the operation it had been a two-inch slit. No trace of suture material was found though fine silk had been used throughout. The two loops of jejunum nearest the stoma were distinctly widened and must have acted as receptacles at the time of eating by filling immediately. No glands or thickenings were anywhere. The patient had been somewhat anæmic as long as we knew him, but the general appearance had remained much the same through all the years.

FIG. 7.—Mr. J. B. Carcinoma solidum. High power. Shown for comparison. Cure lasting fifteen years and one month.

Pathologists a number of years ago began to feel quite doubtful as to the justification of calling a five-year cure with sufficient assurance a permanent one and asked for eight years of freedom from recurrence. This does not mean more than that at such a late date recurrences would be of rather insignificantly small percentage. There is no definite limit of time to exclude the possibility of recurrence. Very recently we saw a beginning recurrence one month less than ten years after an operation for carcinoma of the base of the tongue with metastasis in a submaxillary lymph-node. The case had been watched at intervals and was quite well up to the time mentioned. Another case had the first signs of recurrence twenty-two years after operation for carcinoma of the breast. The carcinoma had been rather advanced. A small, hard, whitish lymph-node in the costoclavicular angle had proven carcinomatous. For this reason following the operation the patient received X-ray treatments during six years, the intervals between treatments gradually becoming wider. For twenty-two years she had no trace of recurrence. Then a crop of numerous small nodules appeared on the chest over the area of the operation and one year later she died of widely disseminated carcinoma. On account of the great number of centres of growth in and near the skin flaps of the previous operation this was definitely a recurrence and not a new malignant formation.

THE IMMEDIATE MORTALITY AND LATE RESULTS OF OPERATIONS FOR GASTRIC AND DUODENAL ULCERS

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of Richmond, Va.

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This paper is a report of the results of the operations I have done for peptic ulcer of the stomach or duodenum over a period of ten years, from July 1, 1919, to July 1, 1929, with the addition of eleven pyloroplasties done before July, 1919. While the latter portion of this period does not comply with the requirement of the symposium to give late results for five years, it affords an opportunity for observation of even the latest cases for at least six or eight months after operation.

No operations done for jejunal ulcer or for malfunctioning of a gastro-enterostomy are included because these conditions are a different problem from that of a gastric or duodenal peptic ulcer, and would confuse the main issue. Also no cases of acute perforation of a peptic ulcer operated upon as an emergency are included. This report, then, contains all of the cases of gastric or duodenal peptic ulcer and of cicatricial contraction resulting from peptic ulcer that I have operated upon during the ten-year period mentioned, and, in addition, it also contains the eleven cases of pyloroplasty operated upon before July 1, 1919.

There was one case of a rather rapidly advancing type of phagodenic ulcer that was not included because of the type of ulcer. It involved most of the pyloric end of the stomach and was accompanied by œdema of the stomach and by enlarged lymph nodes along both borders of the stomach. About half of the stomach was removed, but the ulcer rapidly recurred. A gastroenterostomy was done, but without relief. Necropsy showed extensive ulceration of almost all of the stomach and perforations posteriorly and up toward the liver where these organs had blocked the perforations. There was no evidence of malignancy, but a rapid extension of an ulcerated and inflammatory condition of the stomach quite unlike peptic ulcer.

In the letter sent out to trace these cases, the following questions were asked: "(1) Do you have any symptoms of indigestion or stomach trouble now when you follow ordinary diet? (2) If you have symptoms, do they bother you very much and are they as bad as they were before you were operated upon? (3) If you have symptoms, how soon did they begin after you were operated upon, and are they continuous or are there spells during which you are completely relieved? (4) Is there any particular medicine or diet that seems to give you relief?"

The results have been subdivided into cases which are symptom-free, greatly improved, slightly improved, or unimproved. The "symptom-free" class includes those patients who have no stomach symptoms under ordinary

diet and living conditions, and have had no symptoms of this kind under similar conditions since a few months after the operation. The "greatly improved" are almost symptom-free but will occasionally have some discomfort or slight pain or gas on an ordinary diet. These symptoms do not interfere with the usual occupation and are not sufficient to require any treatment other than the limitation of diet or possibly a dose or two of soda, and occur very infrequently. These patients consider themselves practically well. These two groups are included under the term of "satisfactory results." The "slightly improved" are those in whom the symptoms are pronounced and, while the condition is better than before operation, the patients suffer markedly at times from gas or discomfort or so-called indigestion. A few cases are on the border-line between the "greatly improved" and the "slightly improved." An effort has been made to divide these evenly between the two classifications. The "unimproved" are those patients who are apparently as bad off as, or worse off than, they were before operation. Included in this last group are all the patients who had a recurrent ulcer, for which an operation may or may not have been subsequently done, or who required long periods of treatment without material relief. When a subsequent operation for the relief of gastric symptoms is done, the patient is considered a new case and is again classified from that standpoint.

Of the twelve patients who died following operations for peptic ulcer, on eleven were necropsies done, either limited to the abdomen or including the abdomen and thorax. In one case, a partial gastrectomy, the patient seemed to die from œdema of the lungs and no necropsy could be obtained; but the symptoms and physical signs indicated that this diagnosis was correct.

In all these operations absorbable sutures, usually tanned catgut, were used. The advantages of catgut sutures over non-absorbable sutures, however, are probably not so great as they are often supposed to be. (Table I.)

TABLE I

Report of operations for gastric and duodenal ulcers,
July 1, 1919—July 1, 1929

Operations for duodenal ulcer 124
Operations for gastric ulcer 29
Operations for stenosis 4
Operations for adhesions following pyloroplasty 2
Operations for adhesions following partial gastrectomy 1

 Total 160

Symptom-free . . . . 72—45% ⎫
Greatly improved . . . . 22—14% ⎬ 94, or 59%, with satisfactory results.
Slightly improved . . . . 18—11%
Unimproved . . . . 35—22%
Died (9 necropsies) . . . . 10— 6%
Not traced . . . . 3— 2%

 Total 160

11 physiologic pyloroplasties were done previous to July 1, 1919:

Symptom-free.. 3
Unimproved... 5
Died (necropsies)... 2
Not traced... 1
                                                            ——
Total... 11

No peptic ulcer of the duodenum was operated upon until medical treatment had been given a trial of at least a few months, except in a few cases when the ulcer was extensive or the symptoms severe.

Pyloroplasty.—In June, 1919, I read before the Section on Obstetrics, Gynecology and Abdominal Surgery, of the American Medical Association, a paper entitled "A New Operation for Duodenal and Gastric Ulcer," and reported eleven patients on whom a pyloroplasty termed "physiologic" had been done.

While mechanically this pyloroplasty resembles the Heineke-Mickulicz operation, the principle of it is entirely different and it is for that reason that I have endeavored to keep it from being classed as a modification of the Heineke-Mickulicz. The operation is based on dividing the sphincter and the pyloric canal of the stomach and excising any ulcer that might be in the first portion of the duodenum. Its object is to give physiologic rest by dividing the most active motor portion of the pyloric end of the stomach and to excise the ulcer. It is not a plastic operation and is inapplicable in a marked stenosis, which was the original indication for the Heineke-Mickulicz operation. The incision in the stomach is at least twice as long as the incision in the duodenum, and the duodenum should not be incised for more than an inch.

In this paper eleven cases were reported. Two died directly from the operation, due to secondary hæmorrhage, a hæmorrhage from an ulcer of the stomach sutured intra-gastrically, pyloroplasty being done to facilitate emptying of the stomach; and a hæmorrhage following division of a stenosis of the pylorus in which the constriction was also cut posteriorly. The first occurred twenty-one days after the operation, and the other eight days after the operation.

To July 1, 1929, there are eighty-four pyloroplasties with three deaths. The third death was in the twelfth case in which pyloroplasty was done. This death was due to uremia in a patient who had a nephritis that proved to be somewhat more severe than was anticipated. This was before the days of the more careful functional examination of the kidneys, and at present the examination of the kidney function would probably contraindicate the operation. All three of these deaths could doubtless be avoided now. Since this case there have been seventy-two consecutive pyloroplasties without a death.

Of the eighty-four pyloroplasties, six were for either constriction due to congenital bands, congenital stenosis, pylorospasm, jejunal ulcer or acutely

perforated duodenal ulcer, and are not included in the results reported. Seventy-eight pyloroplasties were for peptic ulcer or for cicatricial contraction due to peptic ulcer. Of these, sixty-nine were for duodenal ulcer, five as an adjuvant for an operation on gastric ulcer, and four for stenosis following ulceration. Of the seventy-eight cases, all but three have been traced. These show twenty-six symptom-free, nine greatly improved, nine slightly improved, and twenty-eight unimproved. Three died. Including the first two groups as satisfactory results, there are thirty-five, or 45 per cent., with satisfactory or good results.

Dividing these seventy-eight pyloroplasties for peptic ulcer or cicatricial contraction into periods of five years, during the first period of five years, of fifty-seven cases, which include the original eleven cases, eighteen are symptom-free, eight are greatly improved (twenty-six with results satisfactory), four slightly improved, and twenty-one unimproved; three died and three are not traced. During the second five-year period, of twenty-one cases, there are eight symptom-free, one greatly improved (nine with satisfactory results), five slightly improved, and seven unimproved. (Table II.)

TABLE II

Pyloroplasty

84 { Pyloroplasties for duodenal ulcer .... 69 }
Pyloroplasties for cicatricial stenosis .... 4 } 78 reported.
Pyloroplasties for gastric ulcer .... 5 }
Pyloroplasties for other causes 6

	First 5-year Period (Old Technic)	Second 5-year Period (New Technic)	Total
Symptom-free.....	18—32%	8—38%	26—33% } 35, or 45%, re-
Greatly improved..	8—14%	1— 5%	9—12% } sults satisfactory.
Slightly improved..	4— 7%	5—24%	9—12%
Unimproved.......	21—37%	7—33%	28—36%
Died.............	3— 5%	0	3— 4%
Not traced........	3— 5%	0	3— 4%
Totals..........	57	21	78

One Finney pyloroplasty was done, for marked stenosis, and is slightly improved.

Two patients have died from diseases not connected with peptic ulcer, and when heard from shortly before death both were symptom-free.

The cause of the unimprovement in many of the pyloroplasties was a recurrent ulcer along the margin of the pyloroplasty incision. In view of the work of Dragstedt and others, who have shown that a peptic ulcer can readily be produced in the pyloric mucosa of a dog by inserting a number of sutures in the mucosa, it was thought that the suturing of the pyloric mucosa as described at first was the cause of these recurrences. Consequently this line of sutures in the pyloric mucosa was abandoned, and after July, 1924 (the beginning of the second five-year period) the operation was done by exclud-

ing the pyloric submucosa from the sutures and suturing the muscular and peritoneal coats of the stomach to the corresponding tissues on the opposite side in the lower part of the wound, and when the duodenum was reached including in the sutures the whole duodenal wall. Then at the upper angle of the wound again only the muscular and peritoneal coats of the stomach were sutured. Care was taken not to grasp the pyloric mucosa even with tissue forceps. Bleeding points in the submucosa were caught in the sutures.

While this type of pyloroplasty has a field, it is narrow. In my earlier enthusiasm I did the operation on a few cases upon which I would now do something else, possibly a gastroenterostomy or a Finney type of pyloroplasty. When there is much infiltration around the ulcer or when the adhesions are at all marked, especially when they involve tissues other than the gall-bladder, this type of pyloroplasty is not indicated. When, however, there is a single, small, well-defined ulcer in the first part of the duodenum that has not responded to medical treatment, and with no adhesions or with adhesions only to the gall-bladder, and cholecystectomy is done at the same time, or when it is desired to give an easier outlet for the stomach as after excision or cauterization of a gastric ulcer, this pyloroplasty seems indicated.

So far as we could ascertain, the great majority of cases of pyloroplasty that were unimproved or very slightly improved were due to recurrence of the ulcer along the suture line, particularly along the upper or lower border where the knots were tied, or to adhesions. Of the cases with recurrent ulcers, three were operated upon by gastroenterostomy, and of these one is symptom-free, one greatly improved (two with satisfactory results), and one unimproved. Of those in which adhesions of the gall-bladder caused the trouble, two were operated upon for division of adhesions and removal of the gall-bladder, and one of these is greatly improved (satisfactory result) and one unimproved. One case was operated upon for excision of a recurrent ulcer and is greatly improved (satisfactory result). Two gastro-enterostomies were done for adhesions, and both patients are symptom-free; one gastroenterostomy was done for recurrent stenosis, and the patient is symptom-free; six partial gastrectomies were done for recurrent ulcer and of these one is symptom-free, three greatly improved (four with satisfactory results), one is unimproved, and one died.

It would seem advisable if pyloroplasty is indicated to do this operation with the chance of curing or greatly improving about 45 per cent. of cases, and of a recurrent ulcer or marked adhesions or stenosis in 36 per cent. The secondary operation would, in these cases, probably be a gastroenterostomy or, in a few cases, a partial gastrectomy. The group that was cured by pyloroplasty seems to be better off than if a gastroenterostomy or a partial gastrectomy had been done as the primary operation, because it is in the type of cases with a wide open pylorus and a small duodenal ulcer that gastro-enterostomy is most unsatisfactory. The cases that are apparently cured are well with the physiological functions of the stomach intact; those that

are unimproved may have to submit to some other type of operation which would be safer and simpler than the operation for jejunal ulcer after gastroenterostomy.

The Finney type of pyloroplasty has been used in only one case. This was done where there was marked stenosis which would be a contraindication for the physiologic pyloroplasty. I have treated the pyloric mucosa in Finney pyloroplasty in a similar way to that mentioned in the last group of pyloroplasties, and though only one Finney pyloroplasty had been done up to July 1, 1929, since that time I have done three.

Gastroenterostomy.—Gastroenterostomy was done in fifty-seven cases. From the first five-year period, containing seventeen cases, ten are symptom-free, three are greatly improved (thirteen with satisfactory results), and three are unimproved. There was one death after operation. From the second five-year period of forty cases, twenty-one are symptom-free, four are greatly improved (twenty-five with satisfactory results), six are slightly improved, three are unimproved, and there were six operative deaths. Necropsies were done after all operative deaths. Gastroenterostomy was done fifty-one times for ulcer of the duodenum, once for recurrent stenosis after pyloroplasty, twice for adhesions after pyloroplasty, twice for recurrent ulcer after pyloroplasty, and once for adhesions after partial gastrectomy. (Table III). During the last five-year period the gastroenterostomy was done without clamps.

TABLE III

Gastroenterostomy

Gastroenterostomies from July 1, 1919, to July 1, 1929 57
    Duodenal ulcer 51
    Recurrent ulcer after pyloroplasty 2
    Stenosis after pyloroplasty 1
    Adhesions after pyloroplasty 2
    Adhesions after partial gastrectomy 1

	First 5-year Period	Second 5-year Period	Total	
Symptom-free	10—59%	21—53%	31	38, or 67%, results satisfactory.
Greatly improved . .	3—18%	4—10%	7	
Slightly improved . .	0	6—15%	6—11%	
Unimproved	*3—18%	†3— 8%	6—11%	
Died	1— 6%	6—15%	7—12%	
Totals	17	40	57	

   * Two of these patients had jejunal ulcers following gastroenterostomy with clamps for duodenal ulcer.

   † One patient had jejunal ulcer following gastroenterostomy without clamps for duodenal ulcer.

Of the seven deaths, two were from cardiac disease. In one of the patients it was known that the heart was in bad condition, but the ulcer was causing such marked symptoms that it was thought best to operate. He died two days after the operation. In another case the patient was seventy-three years old and there was cardiac failure

after three days. In one case, Mr. O., there was death from leakage in the anterior border of the gastroenterostomy. The symptoms of leakage were not very definite until shortly before death, the patient being rather fat and having some pulmonary congestion. Necropsy showed peritonitis from leakage along the anterior border of the gastroenterostomy and apparently no attempt at healing at any point throughout the whole line of suturing. Although death was on the fifth day, when the stitches were cut the jejunum and the stomach fell apart as though the suturing had just been made. Up to that time (March 11, 1929), I had been placing only two rows of sutures, the inner including all coats and the outer burying the inner row. Since then, however, I have been using three rows of sutures anteriorly.

In another case, Mrs. C., the origin of the jejunum was far to the left of the midline. The patient was rather stout, and the stoma never functioned. There was obstruction in the distal limb of the jejunum due to a kink. A secondary operation was done to straighten this out, but the patient died seven days after the gastroenterostomy. The gastroenterostomy was mechanically faulty.

In another case, Mrs. G., there was an obstruction coming on several days after operation, due to a plastic peritonitis which included the upper loops of the jejunum. This was apparently from a mild infection. It was the type of case that Bevan has included in what he terms "gastroenterostomy disease."

In one patient, Mr. P., there was an extensive infiltration of the duodenum and the gall-bladder was adherent over the duodenum. The gall-bladder was lifted up in order to inspect the duodenum, which seemed firm and brawny. A gastroenterostomy was done and the patient made an immediate satisfactory recovery. On the second day, however, he had pain in the abdomen and shortness of breath, and pain in the chest. As the pain was not very severe, and as some pain following the operation is natural, the diagnosis was not clear. The muscle spasm was not pronounced. He died about twelve hours after the first marked symptoms. Necropsy showed the gastroenterostomy was in good condition but the duodenum had perforated. Evidently there was lymphatic exudate which had bound the gall-bladder over the duodenum and when the protecting gall-bladder was separated the gastric juice digested the fibrinous exudate. There was a small round hole about 1 centimetre in diametre in the duodenum, and the peritoneal cavity was flooded with gastric juice and duodenal contents. The patient died from shock from what was evidently a chemical peritonitis. Since that time I have had several other cases with the same condition, and have not disturbed the gall-bladder but have sutured the tissues around it.

The seventh death was Mr. ·W., who had a subacute perforation of a duodenal ulcer. It had been partly walled off, and had existed doubtless for several days. After separating the adhesions a small amount of necrotic material was found in the tissues over the ulcer. The perforation was closed by sutures and as this seemed to produce rather marked obstruction, a posterior gastroenterostomy was done. The next day the patient ran a very high temperature and developed pulmonary symptoms, and died six days after operation. Necropsy showed the abdominal condition satisfactory. There was inflammatory infiltration in portions of the lungs; though a complete necropsy on the thorax was not permitted, a small portion of the lung was reached through the diaphragm. Death was apparently due to bronchopneumonia.

Gastroenterostomy has a definite field in the surgical treatment of peptic ulcer, probably the largest field of any operation. It is used when the duodenal ulcer is large, the adhesions are extensive, when there is marked stenosis or inflammation (duodenitis), or when there is a recurrent ulcer after pyloroplasty. If stenosis is not present, the pyloric end of the stomach is ligated with kangaroo tendon, just snugly enough to produce occlusion but not tightly enough to cut off the blood supply. This occlusion lasts several

weeks, and in some cases several months, but apparently long enough to give the ulcer an opportunity to heal.

Partial Gastrectomy.—The number of partial gastrectomies for peptic ulcer is thirty-two. The gastrectomies on the whole have given satisfactory results, but probably because they were done in most cases for gastric lesions.

In one patient, Mr. McD., a gastrectomy was done because there was a large perforation in the duodenum which had been plugged by the gall-bladder, and it seemed impossible to close the defect without a partial gastrectomy. The patient made an immediate satisfactory recovery, but complained of pain afterwards, which seemed to be due to spasm in the stomach and to the adhesions around the duodenum and the line of union. A posterior gastroenterostomy was done, and afforded him almost complete relief. There was no recurrence of the ulcer.

In twenty-two cases of partial gastrectomy a modification of the Billroth I operation, which I have described elsewhere, was done; in three cases the Finney method; in one case, the Hofmeister; in three cases, the Polya method; in one case, the Billroth I; and in two cases, sleeve resections. (Table IV.)

TABLE IV

Partial Gastrectomy

Partial gastrectomies from July 1, 1919, to July 1, 1929.................... 32

	Horsley	Hof-meister	Polya	Finney	Billroth I	Sleeve Resection	Total
Symptom-free.....	11	1	1	2	0	2	23, or 72%, results satisfactory.
Greatly improved..	4	0	1	1	0	0	
Slightly improved..	2	0	0	0	0	0	2— 7%
Unimproved.......	4	0	0	0	0	0	4—13%
Died (1 necropsy)..	0	0	1	0	1	0	2— 6%
Not traced........	1	0	0	0	0	0	1— 3%
Totals..........	22	1	3	3	1	2	32

Twenty-one cases for primary gastric ulcer:

	First 5-year Period	Second 5-year Period	Total
Symptom-free.................	3	11	14
Greatly improved.............	0	4	4
Slightly improved.............	0	1	1
Unimproved..................	0	1	1
Died......................	1	0	1
Totals......................	4	17	21

Four cases for primary duodenal ulcer:

	First 5-year Period	Second 5-year Period	Total
Symptom-free.................	0	2	2
Unimproved..................	0	2	2
Totals.....................	0	4	4

Seven cases for recurrent ulcer after pyloroplasty:

	First 5-year Period	Second 5-year Period	Total
Symptom-free....................	I	o	I
Greatly improved...............	2	o	2
Slightly improved...............	o	I	I
Unimproved....................	o	I	I
Died..........................	I	o	I
Not traced....................	o	I	I
Totals.......................	4	3	7

There were two deaths, one after a Billroth I operation for gastric ulcer. No necropsy could be obtained, but clinically, the death, the day after operation, seemed to be from pulmonary œdema. The other death followed five days after a Polya operation for recurrent duodenal ulcer after pyloroplasty. There were marked symptoms of pain and muscle spasm. Necropsy showed death due to perforations of an apparently acute ulcer in the posterior wall of the stomach.

Miscellaneous Operations.—This group includes three cases. In two cases the ulcer was excised: one was a gastric ulcer, and the patient is now symptom-free, and the other was a duodenal ulcer and there was recurrence of the ulcer. In one case the Devine operation was done for an old duodenal ulcer with adhesions, with a recurrent ulcer in the stoma and in the stomach after about six months.

CONCLUSIONS

This report must be considered with the fact in mind that almost all of these patients that were operated upon had been treated medically without cure or marked relief. It seems probable that the vast majority of cases of peptic ulcer can be cured either by medical treatment consisting largely of regulation of diet, or by operation. After any stomach operation medical treatment, particularly regulation of the diet, should be carried out for at least several months. This is just as essential in a stomach that has been temporarily crippled by the operation, until it can recover its tone and function, as it is to use splints after an accurately set fracture until the bone itself has become strong.

The kind of operation done should be suited to the type of lesion present. In a few patients, however, there seems to be an inherent tendency toward recurrence of a peptic ulcer even after multiple operations and careful medical treatment. Fortunately, they constitute a very small percentage of the total number of patients with peptic ulcer. This group can usually be effectively managed along lines of rest for the stomach, such as feeding by jejunostomy for months or even permanently, as recommended by Balfour.

THE IMMEDIATE MORTALITY AND LATE RESULTS OF OPERATIONS FOR PEPTIC ULCER

PERFORMED IN THE PRESBYTERIAN HOSPITAL OF CHICAGO BETWEEN 1915 AND 1930

By Doctor Gatewood

of Chicago, Ill.

Ever since Rydygier performed his first pyloroectomy,[1] in 1881, and then made the first gastroenterostomy for benign duodenal obstruction,[2] in 1884, the problem of the proper treatment of peptic ulcer has been one for the careful consideration of medical men. During the period beginning about 1910, and interrupted by the untimely death of Dr. B. W. Sippy (August 15, 1924), this problem was attacked at the Presbyterian Hospital as a joint piece of clinical research by Doctor Sippy and Doctor Bevan with the co-operation of the other members of the staff.

To conform with the purposes of this symposium I have divided this study into: first, the period between 1915 and 1925 (A), and second, the period from 1925 to 1930 (B). The attempt is to make a complete analysis of the results obtained from operations done in the first period (A). During this period there were 2056 patients admitted to the hospital and discharged with the diagnosis of duodenal or gastric ulcer. Of these, only 207, or 10 per cent., came to operation with a total of 218 separate operations. Excluding thirty acute perforations, almost without exception these patients were seen and managed medically before coming to operation. In occasional instances of extreme obstruction, this management was very short, but frequently it lasted for many months. The average duration of symptoms prior to operation was fourteen years in the cases where date of onset was given. Very often the history merely states "many years," and in some cases the time is not stated. It is obvious that we are dealing with a selected group of patients, the majority of whom are usually classed as "medical failures" although not infrequently the ulcer was found healed at the time of operation.

During this period, thirty patients entered the hospital on account of troubles *after surgical therapy*, chiefly gastroenterostomy. As I have reported nineteen of this group in 1925,[3] I will add only that recurrent hæmorrhage was the most common symptom bringing the patient to the hospital—that gastrojejunal ulcer after gastroenterostomy could be demonstrated in six, and, after gastric resection, in two; vicious circle in two; probable recurrence of the old ulcer or a new ulcer in six; and an unnecessary operation in one. In the remaining thirteen cases, the symptoms were attributed to extragastric causes, such as colitis and gall-bladder disease without demonstrable peptic lesion.

RESULTS OF OPERATIONS FOR PEPTIC ULCER

CHART I

Operations for Ulcer

Type of Operation	(A) 1915 - 1925			(B) 1925 - 1930			(A) + (B)		
	No.	Hosp. Deaths	%	No.	Hosp. Deaths	%	No.	Hosp. Deaths	%
Gastroenterostomy............	163*	3	1.8	101*	4	4	264	7	2.7
Gastric resections............	13	0	0	17	0	0	30	0	0
Pyloroplasty.................	4	0	0	1	0	0	5	0	0
Excisions...................	3	0	0	0	0	0	3	0	0
Vicious circles..............	4	0	0	2	1	50	6	1	17
Explorations, etc.	10	1†			5	1†			
Perforations................	30	6	20	18	8	44	48	14	29

* Series (A): 160 Posterior G.E.   * Series (B): 100 Posterior G.E.
　　　　　　3 Anterior G.E.   1 Anterior G.E.
　　　　　　† Gastrogastrostomy   † Taking down old G.E.

Under "explorations, etc.," are included taking down of gastroenterostomies, gastrogastrostomy, and a number of gastric ulcers which were left alone at the instigation of Doctor Sippy.

The first table (Chart I) covers the type of operations done in both periods, A and B; and the total, A + B, gives the hospital mortality for the entire period. Of the seven deaths, two died of pneumon'a, or empyema, two of peritonitis, one of intestinal obstruction independent of the stomach operation, one of continued gastric secretion complicated by herniation of the jejunum into the stoma and one of uretero-pyelo-nephritis. It is of interest to note that only two of these patients who died had been on recent ulcer management or had had pre-operative preparation.

While we have attempted to follow every patient operated upon during this period, this report is concerned chiefly with the ultimate results in the gastroenterostomies. This follow-up has been conducted by (1) personal interview; (2) by report from the surgeon who performed a later operation; (3) by report of attending physician; and (4) by questionnaire. We have been able to obtain accurate data upon all but three patients who report any trouble.

Out of 163 gastroenterostomies, there were three hospital deaths, or a mortality rate of 1.8 per cent. Including these, we have the final results in 89.6 per cent. of all cases, or in 87.7 per cent. of the patients who left the hospital. Seventeen have not been found by diligent search, leaving 146 cases as the basis of this report. One hundred, or 67.7 per cent., of these patients report themselves as entirely, of 100 per cent., well. There were twenty, or 13.7 per cent.. who are much improved—some saying 90 per cent.— but having occasional abdominal distress. especially after indiscretions in diet. In the majority of these, the present complaint was definitely due to bowel distress, gall-bladder disease or other extragastric cause, and no X-ray evidence of ulcer could be found. Two have had presumptive gastrojejunal ulcer based on recurrent distress, history of hæmorrhage, relief from soda

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and localized tenderness over the stoma. Both are well several years after medical management. Some of these patients doubtless have recurrence of old ulcers and, in some instances, the ulcer may never have healed. There were sixteen who are classed as "No Improvement or Worse." Eight of these are dead of gastric disease (including subsequent operative procedures). In the last two groups, we find nine, or 6 per cent., of proven gastrojejunal

CHART II

Results of Gastroenterostomy Done for Peptic Ulcer
(Jan. 1, 1915—Jan. 1, 1925)

Results	No.	%
Cured..	100	68 } 82%
Much improved................................	20	14 }
Not improved by G.E.	16	11
Late gastric deaths*..........................	8	5.5
Deaths from other causes†....................	7	4.8
Hospital deaths‡..............................	3	2

* Late gastric deaths.—Hæmorrhage, five and one-half years; perforations, five years; suicide on account of g. j. ulcer; "stomach trouble," three and seven years; carcinoma of stomach following duodenal ulcer (three cases), two years, three and one-half years, and five and one-half years.
† Deaths from other causes.—Suicide, five years; tuberculosis, five years; heart disease, three years; aortic aneurism, five years; diphtheria, two years; stroke, five years; accidental death, six years.
Five of these patients were reported by doctors or relatives as having had no further stomach trouble. This would increase the percentage of cures to 71 per cent. and the total cures and improved to 85 per cent.
‡ Hospital deaths.—Pneumonia and empyema, twenty days; peritonitis, six days; peritonitis, two days.

ulcers. Four of these were operated upon in other clinics, four at the Presbyterian Hospital and one came to autopsy. Two of these nine are included in the deaths enumerated in Chart II. In addition, there were at least two who might be termed as gastrojejunal ulcer suspects.

A review of the perforations in period (A) shows that nineteen were operated upon within the first twelve hours with only one death, or a mor-

CHART III

Acute Perforations 1915–1925

Operation	Location				Deaths	Known Recurrences
	Gastric	Duodenal	Not Stated	Total		
Closed only...............	7	11	2	20	4	5
Closed plus G.E...........	0	9		9	1	1
Drained..................			1	1	1	
Totals...................	7	20	3	30	6(20%)	6

tality of 5.3 per cent., as compared with 20 per cent. for the series. That there is little basis for the old notion that the closure of a perforation caused healing of the ulcer and a cure of the patient is shown by the fact that six of this series have had subsequent gastric surgery.

There have been thirty gastric resections done for ulcer in the last fifteen years without a death. In this group there are three known gastro-

jejunal ulcers (10 per cent.). A number of the resections were done in connection with gastrojejunal ulcer following gastroenterostomy. While the tendency is toward more radical surgery in gastric ulcer, it is evident that this operation does not qualify as ideal.

CONCLUSIONS

1. An analysis of 163 patients treated by gastroenterostomy between 1915 and 1925 shows a hospital mortality of 1.8 per cent. with 82 per cent. of the patients well or greatly improved. Of the remaining 16 per cent., 8.5 per cent. died subsequently of some stomach condition and 4.8 per cent. died of other causes. While the majority of this last group were undoubtedly well as far as stomach symptoms were concerned, they have not been included in the known cures. Considering that this report covers a selected group of patients, gastroenterostomy seems to us to be a very satisfactory operation in spite of the failures.

2. Gastroenterostomy for ulcer in the Presbyterian Hospital during the past fifteen years has been followed by a hospital mortality of 2.7 per cent.

3. Acute perforations operated upon within the first twelve hours carried a mortality of 5 per cent. as compared with a total mortality of 20 per cent. Recurrence of symptoms demanding further surgery occurred in nearly all simple closures and the mortality does not seem to be increased by concomitant gastroenterostomy.

4. Gastric resection for gastric ulcer and gastrojejunal ulcer is an operation which has increased in frequency during the past five years. Although the series is small (thirty) there are three known gastrojejunal ulcers (10 per cent.).

5. The pre-operative medical management of all cases for at least a short period before operation seems to be indicated from an analysis of the deaths in this series.

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RESULTS OF GASTROENTEROSTOMY FOR ULCER
OF THE DUODENUM AND STOMACH

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The purpose of any operation for peptic ulcer is fourfold: (1) to relieve symptoms; (2) to protect against complications; (3) to protect against recurrence of ulceration; and (4) to increase life expectancy. All of these purposes should be fulfilled to the maximum, with minimal operative mortality, morbidity, and removal of normal structures.

It is an established fact that the best results of operation for peptic ulcer depend primarily on the selection of cases and the type of operation to be carried out. It should be made clear that in the cases considered here are included only those in which gastroenterostomy alone has been done for duodenal ulcer. It is possible that in some of these cases the results might have been better if some other type of operation had been chosen, such as excision of the lesion with pyloroplasty or excision combined with gastroenterostomy.

Gastroenterostomy for duodenal ulcer.—Five hundred consecutive cases of duodenal ulcer were studied in which gastroenterostomy alone was done, during the years 1918 and 1919. The results are based on reports received after a minimum of five years after operation. In considering recurrence of ulceration, hæmorrhage, and so forth, I have carried out the study through a ten-year period. The operation was performed in most instances in chronic cases, a point of first importance in obtaining good results from an indirect operation. In a few cases, for various reasons, operation was performed in the early stage of the disease, but in such cases good results are not as likely to be permanent as when operation is performed for chronic and long-standing ulceration. In the series were 416 males and eighty-four females, a ratio of five to one.

In 270 of the 500 cases, actual or impending obstruction was noted, although in a considerable number of these it was not manifested clinically and would not ordinarily be classified as obstruction due to ulcer. The rather high proportion of cases in which there was obstruction, however, emphasizes the point that mechanical defects have been one of the chief reasons for advising operation for duodenal ulcer.

In 16.2 per cent. of the cases, a definite history of hæmorrhage had been given by the patient. Pain was a pre-operative symptom in practically all cases; in only 2 per cent. a history of pain was not elicited and in these cases hæmorrhage or obstruction was the indication for operation.

In a most careful survey of the series, from the standpoint of relief of symptoms, it was found that after operation 87 per cent. of the patients

obtained relief which they had been unable to obtain by any other means. In 69 per cent. the relief had been either so complete that the patient had paid no attention to diet or to habits of living, or dyspepsia was so slight as to be readily controlled by simple measures. The latter point is one which has not been given sufficient attention, for it is most significant that gastroenterostomy, done on definite indications, enables a patient to control symptoms easily, whereas previous to the gastroenterostomy the symptoms had been more or less uncontrollable. In 18 per cent., the results could be classified as fair. Whereas, in this group, the symptoms of ulcer were under better control after operation than before, the majority of the patients found it necessary to make certain adjustments in diet, and some of them, in order to maintain good digestion, depended on the occasional use of alkalis. A few patients, in spite of diets and alkalis, reported rather severe attacks of short duration. One of these patients, at a subsequent operation, showed the gastroenterostomy to be in excellent condition; the duodenal ulcer apparently had healed, but cholecystitis and pancreatitis were present. The diagnosis, in this case, had been gastrojejunal ulcer. This is illustrative of the fact that other diseases may be responsible for the symptoms in a consideration of disappointing results following gastroenterostomy. The causes of dyspepsia are so manifold that it cannot be expected that gastroenterostomy would protect the patient against all such possibilities.

In 13 per cent. of the series of 500 cases, the patients did not obtain permanent relief from operation. The causes of failure are too numerous to be considered at this time, and many of them are not related to the stomach or duodenum. Diseases that have been overlooked, failure to remove the appendix, functional disorders, and marked indiscretions in habits of living (particularly the excessive use of tobacco or alcohol), and unwillingness to carry out a reasonable regimen following operation, are the more common reasons for disappointment. A significant feature in this group of cases with poor results is that the average of thirty-six and fifty-eight hundredths years is almost ten years less than the average age of forty-four and eight-tenths years for patients who obtained excellent results, which bears out the fact that the younger the patient, the less the prospects of cure.

In the series of 500 patients, the deaths within five years from all causes were twenty-one (4.28 per cent.). From the standpoint of life expectancy this number bears out the investigation carried out by the Actuarial Society of America, in which it was found that among 500 persons of similar age and sex of the white population of the registration area for 1910 in the United States, thirty-one deaths occurred within the five-year period. The operative mortality in the series of 500 cases was 1.80 per cent., there being nine deaths.

In no case in the series, nor in any other series studied, did perforation of the duodenal ulcer, either acute or subacute, occur after gastroenterostomy had been done. In other words, satisfactory gastroenterostomy apparently afforded absolute protection against this serious complication. In none of the

cases in this group did obstruction of the pylorus develop following gastro-enterostomy, although I have seen obstruction recur in a case in which the gastroenterostomy opening had been made so small that it became occluded. If adequate drainage is maintained, any obstruction at the outlet will be relieved permanently.

It is more difficult to secure permanent protection against hæmorrhage than to secure protection against any other symptom or complication. Forty-five of the 500 patients (9 per cent.) had one or more hæmorrhages after operation, but it is significant that only one of the 500 died from hæmorrhage. The protection against serious hæmorrhage is, therefore, almost complete, a fact which W. J. Mayo has repeatedly emphasized.

The study also confirmed the fact that such hæmorrhages often are directly associated with unusual physical and mental strain, overloading the stomach, excessive use of tobacco and alcohol, and, as Eusterman has pointed out, to gross dietetic indiscretions and severe focal infection. It should be emphasized also that the ulcer was not excised in any case of this series since only cases in which gastroenterostomy alone was done were investigated. Experience has shown that bleeding is more definitely controlled if the ulcer, or ulcers, are excised in addition to gastroenterostomy.

In an investigation of the cause of subsequent deaths in the series, no instance of carcinoma developing subsequent to operation was encountered.

The protection afforded by gastroenterostomy against the formation of a secondary chronic ulcer is approximately 96 per cent. After most careful investigation of the patients operated on again elsewhere, besides those oper-ated on again in the clinic, I have accurate information of twenty cases with recurrent ulceration (4.07 per cent. of 491 cases), and of these gastrojejunal or jejunal ulcer was listed in sixteen cases, a total percentage of 3.26 occur-ring in a period of ten years or more after operation. This incidence of recurrence is considerably less than the operative mortality rate of more radical primary operations carried out in a similar group of cases by even the most experienced surgeons. In some of these cases disconnection of the gastroenterostomy loop has protected against reactivation of the healed duo-denal ulceration, and in other cases excision of the original lesion and pyloro-plasty has proved satisfactory. In the intractable cases of recurrence, partial gastrectomy is indicated, but this operation may fail to protect the patient against the most serious of all complications, that is, a recurrent ulcer in a stomach after resection.

Gastroenterostomy for gastric ulcer.—One hundred cases were studied in which gastroenterostomy alone was done for gastric ulcer, since the surgeon considered it unwise to attempt removal of the lesion. It should be said that the surgical staff of the clinic has always subscribed and still subscribes to the belief and practice that removal of the lesion, if it is reasonably possible, should be a part of the surgical procedure.

This being true, I have been surprised to find so many patients with gastric ulcer who have been completely relieved of symptoms by gastroen-

terostomy alone. I am convinced that gastroenterostomy alone is the operation of choice in those cases in which the size of the lesion, or its situation, or the age or condition of the patient makes the removal of the lesion, by whatever method, a difficult or hazardous procedure. I would emphasize the point, then, that the group of cases studied represents lesions which were relatively irremovable. I have left out of consideration those cases in which the surgeon noted, at the time of operation, the possibility of the lesion being malignant, so that the study comprises 100 cases unqualifiedly classified as gastric ulcer, in which gastroenterostomy alone had been done ten or more years previously. In a few of these, increased experience might justify the removal of the lesion, but I believe that any improvement in results following radical operation would be more than counterbalanced by the risks of gastric resection.

The operative mortality in this series of 100 cases was 3 per cent. Pain had been the predominant symptom in all cases; in 24 per cent. gross hæmorrhage had been reported, and in 63 per cent. obstruction in some degree had been present. The latter point is worthy of note, since in many cases of even marked obstruction neither the lesion nor the induration about it involved the pylorus.

Seventy-nine per cent. of the patients, five years or more after operation, were relieved. In 50 per cent. the relief had been complete; in 29 per cent. slight and easily controlled symptoms occasionally occurred, the patient considering the results of operation as good. In 4 per cent. the result was classified as fair; that is, the patients were better than before operation, but the condition was not sufficiently relieved to be classified as good. In 17 per cent. the result was poor; that is, little, if any, relief was obtained from the operation.

Gastroenterostomy affords almost complete protection against the complications of perforation and obstruction. One patient was operated on elsewhere because of perforation, but I am not sure that the perforation occurred in the original lesion. Two patients were operated on subsequently for obstruction. Nine and twenty-seven hundredths per cent. of the patients were reported to have had hæmorrhage after operation. The possibility of carcinoma developing in the unremoved lesion is most important; in six cases such a sequel was established or suspected. The fact that all of these cases were listed as gastric ulcer at the time of operation should be conclusive evidence that there is a relationship between gastric ulcer and gastric carcinoma. The desirability, therefore, of removing a gastric lesion is clear, but it should not be removed if removal is a greater risk than the liability of the development of subsequent serious complications.

The subsequent deaths from all causes in this group during five years after operation were seventeen. The expected deaths in a similar number of persons of the general population of the same average age in the same period would be slightly more than six. The death rate in the ulcer group, therefore, was two and a half times the normal.

The protection against recurrence or reactivation of ulcer afforded by *gastroenterostomy alone for gastric ulcer is approximately 96.90 per cent.* It is a significant fact that gastrojejunal ulcer is not a problem in the treatment of gastric ulcer since the complication did not occur in this group. In cases in which the operation of choice, namely, excision and gastroenterostomy, is possible, gastrojejunal·ulceration is almost unknown.'

The outstanding fact in the study of this series of 100 cases is that an indirect operation alone for gastric ulcer can be depended on to give a high percentage of good results in cases in which the removal of the lesion, by any method, is difficult, and partial gastrectomy is associated with prohibitive operative risk and an unwarranted sacrifice of the stomach.

Comment.—To avoid any misunderstanding as to the purpose of this presentation, it must be said that gastroenterostomy alone for both duodenal and gastric ulcers, particularly the latter, has been used in selected cases; that is, cases in which other types of operation such as excision and reconstructive gastroduodenostomy, partial duodenectomy, or partial gastrectomy, did not appear to meet, as satisfactorily as gastroenterostomy alone, the requirements laid out in the first paragraph of this paper.

THE RESULTS OF OPERATIONS FOR EXCISION
OF ULCER OF THE DUODENUM

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The results of the treatment of ulcers of the duodenum will probably not be greatly improved until we know more about the origin of the ulcer. It is now known which type of ulcer will respond to the benefit of dietary and medical treatment and should have the benefit of such a regimen. Craftsmanship in the surgical treatment of ulcer has probably developed as far as it is possible to carry it on.

The problem of the etiology of duodenal ulcer has been studied from the clinical, experimental, anatomic and pathologic points of view, and each period brings out new factors, yet the real cause remains unknown.

As a result of better Röntgen-ray examinations and of more frequent and complete post-mortem examinations, we are now realizing that duodenal ulcers are very common. Many of the attacks of dyspepsia which were formerly passed off as of no consequence are now known to be caused by duodenal ulcer. If it were not for the fact that in a small proportion of cases the ulcer perforates, and that in another small group severe hæmorrhage may occur, which occasionally proves fatal, duodenal ulcers might be considered very simple lesions. Carcinoma rarely, if ever, originates in the first portion of the duodenum.

The first local operation for ulcer of the duodenum performed in the clinic was in 1896, and the first excision of a duodenal ulcer was done in 1902; from that time on only a few patients were operated on each year. There are two chief reasons why the operation of excision of ulcer of the duodenum has not gained rapidly in popularity: (1) the results of gastroenterostomy when performed for this condition have usually been satisfactory; and (2) unless the first portion of the duodenum is free and mobile, excision of the ulcer may be very difficult. Unless it is possible to excise the ulcer with less risk and better results than attend gastroenterostomy, there is no occasion for this operation. The ideal operation for any condition is the one which removes the lesion causing the trouble, with a minimum of disturbance, and leaves the least possible chance for recurrence.

If it were not for the occurrence of secondary ulcers in the jejunum in certain cases after gastroenterostomy, the results of this operation in cases of duodenal ulcer would be almost perfect. It is impossible at present to estimate how often jejunal ulcer occurs or to specify the type of case in which it is likely to develop. One of the most interesting phases of the problem seems to be that certain individuals are predisposed to the formation of ulcer and that in such persons ulcer will form repeatedly in spite of eradica-

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tion of all foci of infection and notwithstanding the most rigid treatment and precautions with regard to diet, both before and after operation.

In October, 1926, at the Western Surgical Association, one of us (Judd) reported the method in the clinic of excising duodenal ulcer and the results obtained up to that time. The operation which we now use is the same as we were using at that time, except that as our experience increased, we realized that wide removal of the upper part of the duodenum and particularly of the sphincter gave better results than the earlier operation. Our first operations for excision of ulcer of the duodenum consisted in simple excision without disturbing the pyloric sphincter. It is interesting to find that in these cases the symptoms were not always completely relieved in spite of the fact that the ulcer seldom recurred. The operation was then extended by dividing the pyloric sphincter after excising the ulcer. The ultimate results were identical with those in which nothing had been done to the pylorus, but because of the larger opening on the gastric side, the operation was technically easier to perform. Since certain of the symptoms of ulcer are the result of tension and spasm due to the action of the sphincter, it seemed advisable in all operations for ulcer to do something that would permanently eliminate the action of the sphincter. Plastic procedures, such as dividing and suturing in the opposite direction, and, in fact, any type of plastic operation which leaves the sphincter, do not remove the activity of the sphincter. Function of the sphincter may be slight for some time postoperatively, but after complete healing it is usually just as active as before the plastic operation was performed. Alvarez has studied a number of such cases from the physiologic standpoint and from the standpoint of the motility of the stomach both before and after operation, and it is his belief that it is necessary to remove a large part of the sphincter in order to destroy its activity. Removal of all of the muscle necessitates complete pylorectomy. This seems to be a more formidable operation than is warranted in cases of simple duodenal ulcer, and furthermore, it may be followed by scar tissue and contracture which will interfere with the lumen. A much more conservative and simple operation is the excision of the anterior part, with as much of the sphincter as can be removed easily. This usually amounts to two-thirds to three-fourths of the muscle. Even after such extensive removal, Alvarez has noticed that there is still a tendency for the lumen at the pylorus to narrow by contraction during the process of digestion. Such narrowing may result from the contracture of the small remnant of sphincter muscle left after excision, or it may result from the contracture of the musculature at the pyloric end of the stomach. Doing away with this activity of the sphincter in conjunction with excision of the ulcer of the duodenum is the most important step in the operation. The technical steps of the operation are not difficult so long as good exposure is obtained, and closure is readily carried out if the operation is not attempted in cases in which the ulcer is too far distant from the pylorus, or in which the duodenum is too firmly fixed to be readily mobilized.

Multiple ulcers.—Increasing experience with the local operation on the duodenum impresses us with the fact that in most instances ulcers are multiple. We usually find an ulcer with a definite crater, or a localized area of duodenitis on the anterior surface of the duodenum, about 1.5 centimetres below the pylorus and close to the upper border of the duodenum. When the duodenum is opened this is found to be a separate and distinct lesion, but also, in almost every case, there is a localized area of duodenitis on the posterior wall of the duodenum just below the pyloric sphincter. In a small proportion of cases there is an ulcer with a definite crater at this point. Although ulcers do occur in other parts of the duodenum, they are exceedingly rare as compared with the areas mentioned. The area of duodenitis or ulcer on the posterior wall is much less extensive than the lesion on the anterior wall and might well be classified as a secondary lesion. In many cases, the posterior lesion may be excised without difficulty; in certain cases it seems best to destroy it with the cautery, and in others, it may be necessary to cut out the ulcer and suture over the posterior surface of the duodenum. We have often treated posterior ulcers in this manner with good results, whereas if the posterior lesion is duodenitis, it has been disregarded.

The operation as we now do it, with extensive removal of the muscle of the sphincter, produces about the same physiologic changes as occur in cases in which gastrojejunostomy is performed. The stomach and duodenum are converted into one continuous part of the gastro-intestinal tract, the contents of the stomach passing quickly into the duodenum. Usually the emptying time of the stomach is not as rapid as it is in cases of gastrojejunostomy. The gastric acids are reduced, but they are rarely absent, as they often are in cases in which gastrojejunostomy has been performed. With the absence of activity of the sphincter, there is an opportunity for the duodenal contents to flow into the stomach, so that if there is anything in the neutralizing effect of these fluids, this is accomplished just as well after this operation as it is after gastrojejunostomy.

Indications for excision and partial duodenectomy.—In view of the fact that we have demonstrated that partial duodenectomy can be done with greater safety than gastroenterostomy, and furthermore, that the ultimate results are as good as they are in gastroenterostomy, we believe that it should be carried out in every case of duodenal ulcer in which it is feasible to do so. We believe, also, that when possible gastroenterostomy should be avoided because of the severity of the symptoms that result when a jejunal ulcer forms. We especially prefer excision and partial duodenectomy if the patient is young, because young patients are more prone to secondary ulcer than patients in middle age and past middle age. We believe that this operation offers all that gastrojejunostomy offers, and removes the ulcer as well. The recurrence of ulcer in the duodenum is not as serious as the formation of a jejunal ulcer. It is an interesting observation that in the nine cases in which we operated after excision of the ulcer and the sphincter, in only one case were we able to demonstrate recurring ulcer. In the other cases, the recur-

rence of the symptoms seemed to be due to the fact that the operative field had been surrounded and interfered with by the formation of adhesions. In the 464 cases in which extensive removal of the upper part of the duodenum with the pyloric sphincter was carried out, there has not been any evidence of infection from the soiling which is bound to occur during the procedure. The operation is done without clamps so that a certain amount of gastric and duodenal contents escapes into the field, but general peritonitis has not followed in any case. In one case, local peritonitis developed later into a sub-phrenic abscess, but this cleared up immediately after drainage was established. The abscess may have resulted from leakage through the suture line. If so, this was the only case in which there was any suggestion of leakage or perforation following the operation. These results would seem to speak well for the healing power of these tissues, since we were not able in all cases to make an accurate approximation. Stenosis following the plastic operation and following the Billroth I type of operation is not an uncommon occurrence. We have found it necessary to reöperate in many of these cases because of stenosis. We believe that this shows the advantage of saving the posterior part of the duodenum and pyloric sphincter, since in one case only, following this operation, did stenosis of any consequence develop from narrowing of the lumen, and in this case practically the entire circumference of the duodenum and all of the sphincter had been removed. In a few cases, following extensive excision, there was temporary retention, which required treatment for a few days only.

Limitations of the operation.—Fixation of the duodenum and deformity due to long-standing trouble necessitate limiting the operation to a certain extent. The good results we have obtained from excision and partial duoden-ectomy have undoubtedly been due to the fact that the operation has been performed in those cases in which the duodenum was not fixed or extensively deformed. We believe that gastroenterostomy should still be performed if the duodenum is fixed or extensively deformed, and we believe the operation to be uniformly successful in elderly patients with a long-standing history of ulcer, but a local operation should be done on young patients, even if it necessitates mobilizing the duodenum, and a rather extensive operation.

Results of local operations.—A study of the end-results of the local operations for duodenal ulcer shows that the operation can be done with very little risk. The hospital mortality in this group is low and the relief obtained from symptoms is about as complete and as lasting as from gastro-enterostomy.

Table I shows a classification of all of the cases in which operation was performed at the clinic. Early in this work, the operation consisted in excis-ing the ulcer or destroying it with the cautery and then closing the opening in the duodenum, often without exploring the duodenum for other ulcers and without making any attempt to change the activity of the sphincter. The results in these cases were not entirely satisfactory, largely because some of the patients had persistent dyspepsia. Secondary operation rarely revealed

recurrence of the ulcer. Excision of the ulcer and gastroenterostomy was performed in 219 cases. This procedure gave satisfactory ultimate results, but the immediate risk of the operation was increased. Such operation might well be reserved for those cases in which a deep posterior ulcer is discovered after an anterior ulcer has been removed. Moynihan is of the opinion that the ulcer in these cases should be excised or sutured over, always in addition to gastroenterostomy. Excision and gastroduodenostomy or pyloroplasty, which was performed in 1,002 cases (Table I) included all of the different types of pyloroplasty, such as the Heineke-Mikulicz operation, the Finney operation, the Horsley and Mayo operations, and the operation now in use at the clinic. There were two deaths in this group of cases and in neither was death due to the technical failure of the operation. With increasing experience in these cases, we began to feel that it was also necessary to remove the ulcer and to interfere with the sphincter considerably in order to obtain satisfactory results. We soon found that the best way to do this was

TABLE I

Procedures in Local Operations for Duodenal Ulcer and Duodenitis
(1906 to 1929, Inclusive)

	Operations	Hospital mortality	
		Cases	Per cent.
Excision alone (knife or cautery)...........................	361	4	1.10
Excision and gastroduodenostomy or pyloroplasty...........	1002	2	0.19
Totals...	1363	6	0.44

actually to remove the greater part of the sphincter. Instead of making the operation more difficult, it simplified the technical steps considerably. With the anterior part of the sphincter removed, together with the cap of the duodenum, suturing of the stomach and duodenum together was simplified. The structures were approximated with less tension and it was easier to maintain a good lumen.

Table II shows the number of cases in which the foregoing procedure has been carried out from 1924 to 1928 inclusive, a total of 464 cases. We have accurate follow-up records in 369 of these cases. Of the 464 cases, 70 per cent. were men and 30 per cent. were women. The average age was forty years. The average duration of symptoms was eight and a half years. Good results may be expected in persons past middle life who have had a prolonged ulcer history when gastroenterostomy is performed. Our records seem to show that the most unsatisfactory group in which gastroenterostomy was done included the younger patients, and for this reason we have attempted to do the local operation in as many of these younger patients as possible. This question of the significance of the type of operation for patients of different ages was not impressed on us until within the last few years, but increasing experience makes us feel that it is an important consideration.

TABLE II

Local Operations for Duodenal Ulcer and Duodenitis
(1924 to 1928 Inclusive)

Operations performed............................ 464 cases
Patients traced................................. ·369 cases
    Males......................... 70 per cent.
    Females...................... 30 per cent.
Average age..................................... 40   years
    Oldest (three patients)........... 67 years
    Youngest (two patients).......... 18 years
Average duration of symptoms................... 8.5 years

Table III outlines the site of the lesion in the different cases. As would be expected, in most instances the ulcer was on the anterior wall of the duodenum. In seven cases the ulcer was on the posterior wall only. Often it is necessary to open the duodenum in order to be sure that there is an ulcer on the posterior wall. If it can be determined that an ulcer with a crater is present on the posterior wall, well below the pylorus, then posterior gastroenterostomy is the better operation. Although it is possible satisfactorily to excise ulcers on the posterior wall, sometimes it is very difficult. In fifty-nine of the cases, there was an ulcer on both the anterior and posterior walls. It is probable that this combination occurred more often than we were able to demonstrate. A small ulcer on the posterior wall may be difficult to find. In almost every case of ulcer on the anterior wall, there is inflammation on the posterior wall. In the cases of ulcer on the posterior wall, the ulcers were excised when possible, and we believe that this should be done whenever it is possible. We have cauterized the ulcer in some cases, and in some cases we have removed the anterior ulcer and have not disturbed the inaccessible lesion on the posterior wall. In this group of cases, the results have been fairly satisfactory, but they were not as good as in those cases in which the anterior ulcer was the principal lesion. In twenty-three cases, the only lesion that we could find was hypertrophy of the pyloric sphincter. These patients all had symptoms of ulcer, although in none was there a good clear-cut history. We opened the duodenum and explored for ulcer, but did not find one. We also examined the mucosa of the stomach in the pyloric region and did not find an ulcer. The hypertrophied muscle was removed in each case, in the same manner as it is removed in excising

TABLE III

Site of Lesion
(1924 to 1928)

	Cases
Anterior wall of the duodenum........................	373
Posterior wall alone..................................	7
Anterior and posterior walls..........................	59
Anterior wall of duodenum and also gastric ulcer..........	2
Hypertrophy of pyloric muscle (ulcer not found)..........	23
Total.....................................	464

duodenal ulcer. About 70 per cent. of these patients were definitely benefited by the procedure, and the others did not obtain relief from symptoms.

Table IV gives a review of the ultimate results as best we could obtain them from our follow-up system. Of the 369 cases traced, in 333, or 90 per cent., the results were classified as satisfactory. If the percentage is calculated from the 464 cases, which would assume that in those that were not traced the results were not satisfactory, then the percentage of good results would be reduced to 70 per cent. The number of patients not benefited was 8.1 per cent. One striking point which came out in the study of the group in which patients were not benefited was that the original history was not definite and clear-cut of periodic ulcer attacks. Certain of the patients had a fairly typical history of ulcer with associate neurasthenia, and some of these reported that they were not benefited by the operation. Others had intercurrent disturbances in addition to the symptoms of ulcer, and frequently these disturbances persisted after the operation for the ulcer. There were two deaths in the group of 464 cases. Six of the patients have died subsequently. Only one of the latter deaths, however, was in any way attributable to duodenal ulcer.

TABLE IV

Ultimate Results
(*1924 to 1928*)

Cases

Operations performed	464	
Patients traced	369	
Results satisfactory	333	(90 per cent. of those traced)
No benefit	30	(8.1 per cent. of those traced)
Hospital mortality	2	(0.43 per cent.)

Subsequent Deaths as Reported

One year after operation: suicide
Two years after operation: operation for recurrent duodenal ulcer
Two years after operation: cerebral hæmorrhage
One year after operation: drowning
Two years after operation: cause unknown
Three years after operation: operation for brain tumor

Table V shows the number of cases in which there was a history of hæmorrhages before the operation as well as those in which there was a history of bleeding since the operation. There was a history of bleeding before the operation in seventy-three cases. There was a history of bleeding after the operation in nine cases. Seven of these patients had one or more hæmorrhages in from four months to two years after the operation. In some cases there was only one hæmorrhage, in others there were several, but in these seven cases the bleeding eventually subsided and no special treatment has been required. It is possible that, in these cases, a recurrent ulcer was the cause of the bleeding. I believe it is more likely that in most of the cases the hæmorrhage came from inflammation in the duodenum. The results in

these cases would seem to indicate that unless the hæmorrhages frequently recur, operation is not required. In the eighth case in this group, bleeding started five months after operation and continued indefinitely. It was discovered that the patient had hæmorrhagic purpura. After his spleen was removed the bleeding ceased. In the ninth case, because of recurring hæmorrhages, the patient was reöperated on and gastroenterostomy was performed. A recurring ulcer could not be demonstrated.

TABLE V

Clinical Manifestations
(*1924 to 1928*)

		Cases
Typical ulcer history		402
Gastric acidity {average combined acids	68	
{average free hydrochloric acid	51	
Hæmorrhage as a symptom		
History of bleeding before operation		73 (15.73 per cent. of the 464 cases)
History of bleeding after operation		9

  (1) Hæmorrhage one year after operation
  (2) One hæmorrhage four years after operation
  (3) One hæmorrhage four months after operation; no recurrence fifteen months later
  (4) One hæmorrhage fifteen months after operation
  (5) One hæmorrhage four months after operation; three years since last hæmorrhage
  (6) One hæmorrhage two years after operation
  (7) One hæmorrhage five months after operation
  (8) Repeated hæmorrhages beginning five months after operation; splenectomy for hæmorrhagic purpura in one and a half years; no bleeding since splenectomy (seven months)
  (9) Operation for recurrent hæmorrhages in three years; first hæmorrhage came one year after original operation which was for bleeding duodenal ulcer; second operation: gastroenterostomy; the mucosa of the stomach was red and congested and showed definite gastroduodenitis

Table VI gives a review of the post-operative complications. As is to be expected, the most prevalent complication in this group of cases is that of some form of pulmonary infection. It is a striking observation, however, that in this particular group of cases, in which there is a local operation on the pylorus and duodenum, the patients are not as prone to pulmonary complication as in those cases in which gastroenterostomy is performed, or some other operation is carried out on the body of the stomach. Twelve of the patients in this group had pneumonia, five had pleurisy, three had pulmonary infarcts, and thirteen had bronchitis. Pneumonia was fatal in one case. Phlebitis occurred in eight cases. The wound was infected to a sufficient degree to prolong the convalescence in thirteen cases. In a number of others there was serum in the wound. We believe that the abdominal wound in this group healed better than the abdominal wound in most operations on lesions of the stomach, and that the contamination from this part of the stomach and intestine does not result in severe infection as frequently as it does elsewhere. In spite of the fact that extensive resection of the upper part

of the duodenum was done in many of these cases, in only twelve of them was there gastric retention at any time. In most of these, the gastric retention was temporary and cleared up within a few days, but in three cases it was necessary to reöperate several months later because the stomach did not empty as well as it should.

TABLE VI

Post-operative Complications
(1924 to 1928)

		Cases
Pulmonary..		33
Pneumonia..................................	12	
Pleurisy.......................................	5	
Pulmonary infarct............................	3	
Bronchitis.....................................	13	
Phlebitis..		8
Wound infected to a sufficient degree to prolong convalescence..		13
Gastric retention (temporary)........................		12
Hospital deaths......................................		2
One died from bilateral bronchopneumonia; and one frcm carcinoma of pancreas not recognized at operation		

Table VII gives a short résumé of the cases in which a secondary operation was done because of failure to relieve symptoms by excising the duodenal ulcer and removing the pyloric sphincter. In only one of these nine cases were we able to find a secondary ulcer. The failure of the operation in most cases seemed to be due to the fact that the operative field had become sealed to the parietal peritoneum or to the liver by dense adhesions. In each of these cases in which we were able to mobilize the duodenum at the second operation, we were also able to demonstrate that the lumen at the point of the first operation was sufficient.

TABLE VII

Secondary operation on account of recurrent symptoms (1924 to 1928)

Case

1 Symptoms recurred in five months. Operation in two and a half years. A recurrent duodenal ulcer was found with chronic perforation and attachment to the gall-bladder. Posterior gastroenterostomy was performed.

2 No symptoms for two years, then began having distress with symptoms of retention. Operation in two and a half years. The pyloric end of the stomach was adherent to the round ligament of the liver, suggesting that this caused the obstruction, for when the duodenum was freed the pyloric outlet seemed ample and no ulcer was found. Posterior gastroenterostomy was performed.

3 Symptoms recurred in two years. Operation in three years. Thickening found on superior border of duodenum but no ulcer was present. The duodenum was mobile and there was an ample lumen at the pylorus. Posterior gastroenterostomy was performed.

4 Symptoms recurred in eight months, retention gradually increasing. Operation in two and a half years. Obstruction at the site of the old operation caused by adhesions between the anterior suture line and the parietal peritoneum. No ulcer found. Separation of adhesions and posterior gastroenterostomy were done.

5 Symptoms of retention while still in the hospital. Operation in six months on account of retention. The duodenum was adherent to the under surface of the liver and was not freed. Posterior gastroenterostomy was performed.

6 Operation elsewhere in two years for recurrence of symptoms. Patient died from mesenteric thrombosis.

7 Operation at clinic for bleeding duodenal ulcer. Recurrence of the hæmorrhages in one year. Operation in three years. There was ample lumen at the pylorus; small scar from former operation. No ulcer found. Posterior gastroenterostomy done. The mucosa was reddened. Bleeding probably due to gastroduodenitis.

8 At the first operation there was an ulcer on the anterior duodenal wall, also a large ulcer on the posterior wall; in addition, cholecystitis with multiple stones and chronic catarrhal appendicitis. Appendectomy and cholecystectomy were performed. The anterior duodenal ulcer was excised with the anterior half of the pyloric sphincter. The posterior ulcer was not disturbed. Ten months later there was recurrence of symptoms and the patient was operated on elsewhere. The report stated that partial gastric resection was performed.

9 Symptoms recurred in seven months. Operation in two years. An ulcer was not found in either the stomach or duodenum, and there was very little evidence of the scar of the previous excision. The pylorus was adequate to drain the stomach well. Posterior gastroenterostomy was performed.

SUMMARY

This paper consists of a report of the local operations which have been performed in The Mayo Clinic for duodenal ulcer. The first local operation in the clinic for ulcer of the duodenum was a Heineke-Mikulicz operation in 1896, and the first operation for excision of ulcer of the duodenum was in 1902.

Gastroenterostomy will probably remain the popular operation for duodenal ulcer. It is satisfactory in all cases except in those in which secondary ulcers develop, and in those in which hæmorrhage occurs and in which bleeding may continue.

The operation of excision was developed to be used in those cases in which it was possible to carry it out safely, with the idea of avoiding jejunal ulcer and possibly reducing the number of cases in which bleeding continues after gastroenterostomy for hæmorrhagic ulcer.

For many years, the local operation consisted in excision of the ulcer or destruction of the ulcer by cautery with simple closure of the area in the duodenum. Of late, it has been felt that removal of the anterior part of the pyloric sphincter, in addition to excision of the ulcer, produced more complete relief from symptoms. With this removal of muscle, everything is accomplished that gastroenterostomy can accomplish, and, in addition, the ulcer is removed.

In cases in which multiple ulcers are encountered and in which it is not possible to remove all of them, it is probably best to remove the anterior ulcer, close the opening in the duodenum, and then to complete the operation with gastroenterostomy.

The local operation is limited to those cases in which the duodenum is fairly mobile. As one's experience increases with these cases, however,

one realizes that it is not difficult to mobilize a duodenum that is fairly well fixed, and this should be done in cases in which excision of the ulcer is definitely indicated.

Gastroenterostomy is particularly satisfactory for older patients, especially if obstructive symptoms have developed. Gastroenterostomy is less satisfactory in young patients.

A study of the immediate results from local operation shows that it can be done with very little risk. This report covers 1,363 cases with a mortality of 0.44 per cent.

The ultimate results in this group of cases are practically the same as the ultimate results obtained by gastroenterostomy; the patients in 90 per cent. of the group in which we have detailed reports have obtained satisfactory results.

The local operation can be performed in about 50 per cent. of the cases of duodenal ulcer, and in these, better immediate and ultimate results will probably follow than from gastroenterostomy.

THE ULTIMATE RESULTS AND THE ACTUAL FUNCTIONAL RESULTS AFTER THE DIFFERENT TYPES OF OPERATIONS FOR GASTRIC AND DUODENAL ULCERS, FOR GASTRIC CANCER AND FOR HOUR–GLASS STOMACH AFTER AN INTERVAL OF FIVE YEARS OR MORE

By Joseph C. Bloodgood, M.D.

of Baltimore, Md.

This is a brief summary of forty years' study and observation of surgery of the stomach, especially in relation to resection, gastroenterostomy and Finney pyloroplasty.

When I was writing annual reviews of the literature for the December numbers of Progressive Medicine, published by Lea and Febiger, of Philadelphia, from 1899 to 1918, I remember distinctly short articles by surgeons of more than twenty years' experience, giving, in an authoritative way, their conclusions after this long period of study. I was impressed that I found more of the fundamentals in contributions of this kind. There was nothing original, but brief statements of things that had been tested and found correct.

I have before me the actual histories of cases of lesions of the stomach personally observed by me, and on which I have operated since 1900. I have a number of examples of cases who have lived for more than twenty years since the operation and who are apparently well today. We know the exact function of the stomach from letters from the patients and their physicians. After every type of gastric operation that I have performed I have a post-operative X-ray picture—one of them more than twenty-six years after operation. (1904 to 1930.)

The ultimate results ascertained from patients and physicians have been brought up to April, 1930, by Mr. George Thompson, a student in the medical department of Johns Hopkins and a special student under the Garvan fund in the surgical pathological laboratory. Today he has finally traced an example of duodenal ulcer operated upon in 1911, nineteen years ago, by a modified long-loop gastrojejunostomy of the Roux type. In this case, there were so many adhesions around the duodenum and stomach and involving the transverse colon that I had to do an anterior gastroenterostomy, end-lateral jejunum to stomach, and end-lateral jejunum to jejunum. I performed it with a long loop, because I knew the risk of duodenal dilatation when Roux' method of a short loop is employed. (Jour. Amer. Med. Ass., pp. 59–117, July 13, 1912.) After many years, during which the patient had been lost track of, the students in the follow-up squad finally located him as a motor man running cars past the hospital every day. He still has some discomfort after eating, especially later, when the stomach has emptied. I note this case in some detail in order to record and emphasize the difficulty

of a real follow-up system. To be successful, it must be explained to the patient before he or she leaves the clinic and must begin within a year of their discharge.

Historical.—In reviewing this personal experience of more than forty years of intestinal suture, the surgeon responsible for its introduction, Theodor Billroth, of Vienna, still ranks first. Billroth No. I is an end-to-end suture, and Billroth employed single interrupted silk sutures (not mattress sutures), and three rows of sutures. Figure 1 is a copy of his original drawings, made almost fifty years ago. I know of no new principle since. The Billroth No. II operation (Fig. 11), resection of a portion of the stomach, in which the open end of the stomach was closed followed by gastro-

Fig 1 —Copied from Billroth's Clinical Surgery, 1876 (see text pp 3 and 16). Note the small cancer at the pylorus, the narrow margin given the cancer; the three rows of single interrupted suture; various methods of anastomosing duodenum to stomach. Compare Fig. 7 in the Billroth picture with our Fig. 6.

enterostomy of the lateral type, was forced upon those early operators, because so much of the stomach had to be sacrificed to give a suitable margin to the late cancer or ulcer. For many years Billroth No. I, end-to-end duodeno-gastrostomy, was neglected. The master minds in gastric surgery were trying to perfect gastroenterostomy. Kocher modified Billroth No. I by an end-lateral anastomosis (Fig. 2). L. Clarence Cohn, my associate (ANNALS OF SURGERY, vol. lxxix, p. 229, February, 1924), reviewed my personal experience with this method of anastomosis since 1910. Since that article was written I have personally changed from the Kocher to the Billroth No. I, because the latter could be performed with less tension than the Kocher, and

it was distinctly quicker. The immediate and permanent results, in my hands, have been identical. The only reason to choose Billroth No. I is that one needs less stomach and less time. The literature in the past five years shows that operators in every country are returning to the original Billroth No. I, end-to-end duodenogastrostomy. No modifications have changed the principles, or, as far as I am able to judge, improved the technic. The majority of operators, however, use a continuous suture of catgut, at least for the approximation of the mucous membrane.

In 1886, I witnessed Senn[1] perform lateral anastomosis on dogs, using decalcified bone plates to make the lateral anastomosis, either gastroenteros-
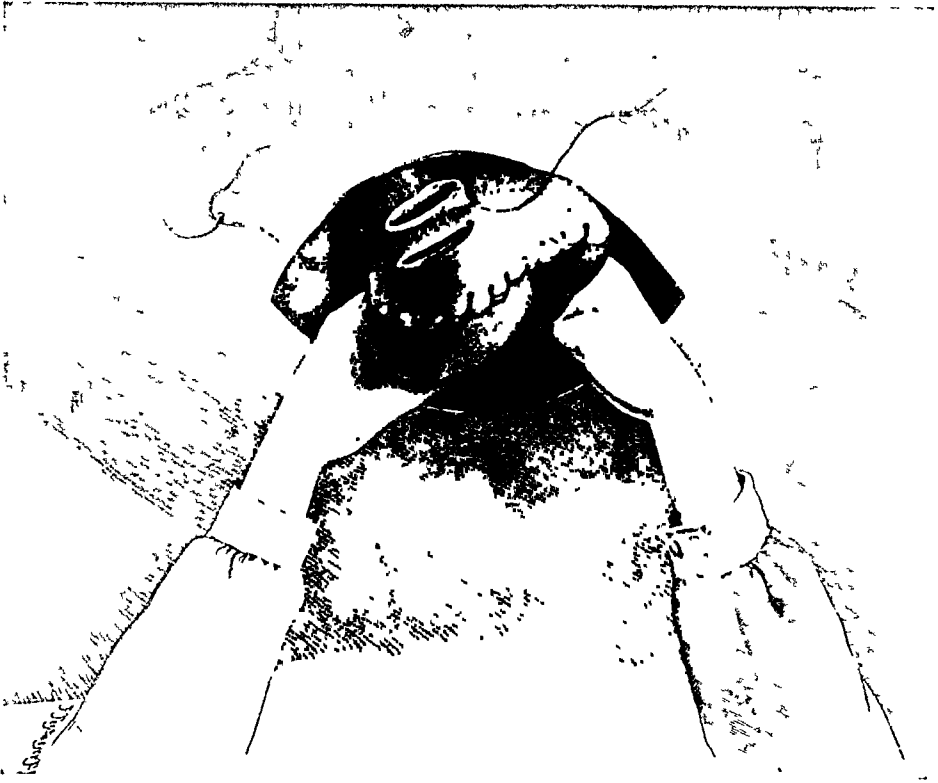
FIG 2 —From Kocher's book on Operative Surgery, to illustrate Kocher's suture after resection of the pylorus Resected end of stomach closed; duodenum sutured to posterior wall of the stomach, end lateral Note continuous suture No statement as to silk or catgut. See text p 3

tomy, entero-enterostomy, or enterocolostomy. Senn was the first (I write from memory) of a group of experienced operators who tried to find a substitute for Billroth's end-to-end anastomosis between the duodenum and stomach and the lateral anastomosis between the stomach and jejunum. As a medical student in the University of Pennsylvania, between the years 1888 and 1891, in the physiological laboratory of Professor Reichert, my classmate, Doctor Heller, and I performed numerous experiments with intestinal su-

[1] Nicholas Senn, Milwaukee (*Jour. Amer. Med. Ass.*, vol. xxi, p 215, 1893). This reference is taken from Cyrus F. Horine, of the department of surgery in the University of Maryland (ANNALS OF SURGERY, December, 1922).

ture on dogs. We found that a rubber tube of the drainage type made into a ring by invaginating one end into the other was just as effective as Senn's bone plate and much less difficult to prepare. I do not remember the name of Billroth being mentioned to us. I am quite certain that if we had seen his illustrations, we would have attempted direct suture.

John B. Murphy,[2] of Chicago, devised his button. In spite of its success, it is rarely used today. The majority of operators have returned to the suture methods of Billroth.

It seems remarkable now that such courageous and skilled operators of the type of Senn, Murphy and McGraw, should have introduced substitutes for Billroth's methods of direct suture.

When I came to Halsted's clinic of Johns Hopkins Hospital, in 1892, I was tremendously impressed with his methods of intestinal suture which he had worked out so beautifully in experiments on dogs and had practically perfected as a method of anastomosis on these animals before Johns Hopkins Hospital opened in 1889. It is important to record here that Halsted used a single row of mattress sutures, and each needle was made to catch the submucosa. The mattress suture not only approximates, but invaginates. The histological studies of sections through the anastomosis on the intestine in dogs showed almost perfect anatomical restitution. I assisted Doctor Halsted with his first gastroenterostomy. He had brought to the operating room reprints of his articles, so that we had before us his beautiful illustrations. The retrocolic route had been established, but little or no attention was paid to the exact length of the portion of the jejunum between the anastomosis and the duodenum, nor, as I remember it, to the direction. Halsted made his anastomosis exactly as he would on a dog, and, it seemed to us, as perfectly. This patient very quickly, on coming out of anæsthesia, began to vomit, and exhibited the symptoms of the then known and feared complication described as a "vicious circle." In forty-eight hours there were symptoms of peritonitis, and at the autopsy on the fourth day there was leakage. One of the stitches had torn out, perhaps due to the vomiting. I helped at this autopsy, but I did not look at the duodenum to see if it was dilated, or to demonstrate the kink as shown in Fig. 3. In the next few years, in Halsted's clinic, there were a few more operations in which a single row of mattress sutures was employed. In more than one-half of them there was leakage and peritonitis. I distinctly remember Doctor Halsted saying to me before 1895 that his experimental work on intestinal sutures in dogs was a failure when applied to man's intestine. Halsted's disappointment and chagrin made a great impression on me. In spite of this, Halsted will always be given credit for calling our attention to the importance of the submucosa as the layer in the wall of the gut through which the needle should pass. The mattress suture also has its place, providing it is reinforced by a second or third row of sutures. Finney has demonstrated this, because in his successful pyloroplasty the first

[2] Med. Record, vol. lxii, p. 665, New York, 1892.

row of stitches which catch the submucosa and not the mucous membrane are of the mattress type.

Horine (loc. cit.), in 1922, mentions 225 different methods of anastomosis and many of them in recent years were attempts to perform resection and suture without contamination. One of the last pieces of experimental work of Professor Halsted was his buttress principle in end-to-end anastomosis,
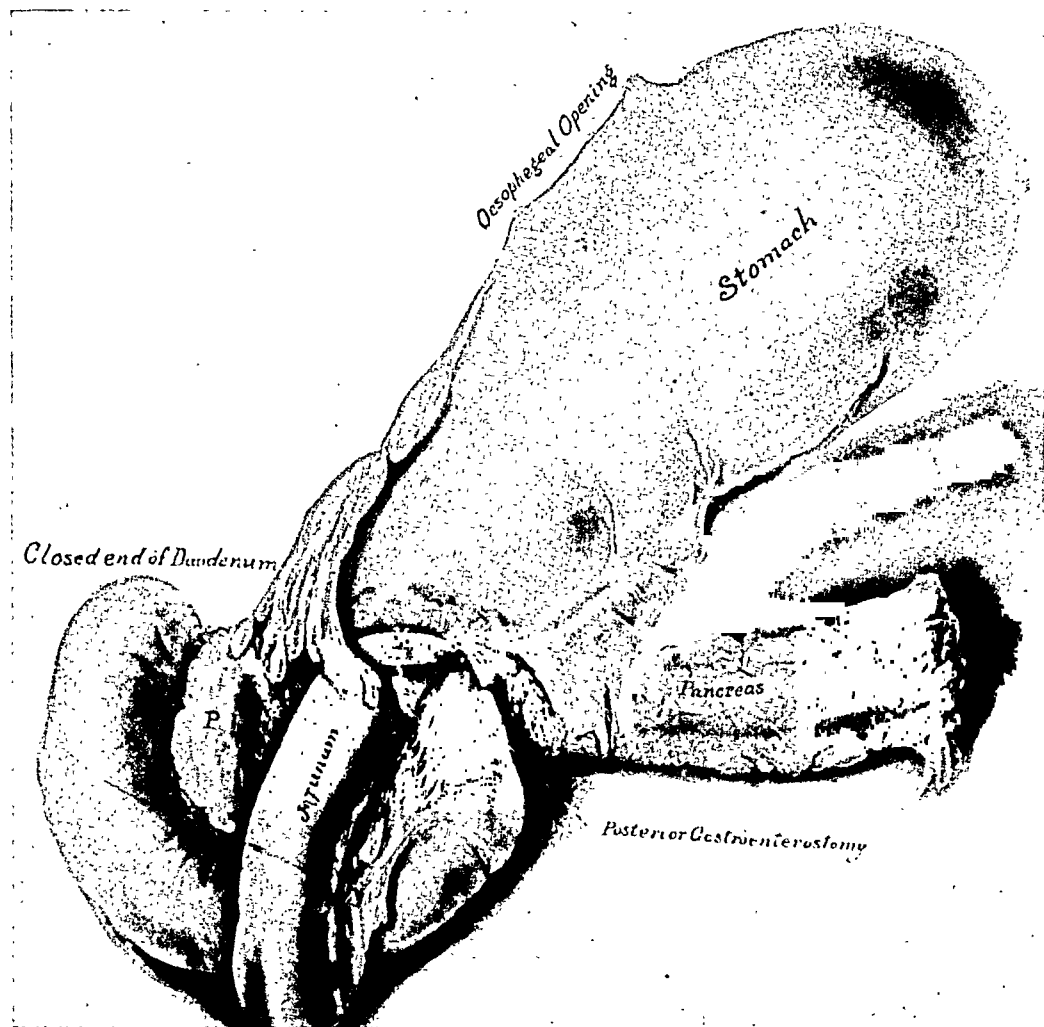
FIG. 3.—Pathol. No. 9871.—Photograph of autopsy specimen some months after resection for cancer with short-loop posterior gastroenterostomy (Billroth No. II). Note the partial kink at X and that the loop turns in the wrong direction, to the right. This anastomosis did not work well for some weeks, but acute dilatation of the stomach did not take place. This photograph illustrates the danger of any short-loop gastroenterostomy after resection.

and there have been many other attempts by Gatch and others. It is important to remember that Billroth not only did not use clamps, but paid no attention to slight contamination. In 1893, when I visited Vienna, I witnessed Billroth operate, and read his original contribution on gastric suture, I decided to follow his technic. For this reason I have rarely used clamps in resection and anastomosis and have, with rare exceptions, used three rows of interrupted suture as originated by Billroth, but I have substituted Hal-

sted's fine black silk pre-operatively threaded on a fine straight needle, or a French curved needle. I have rarely employed the mattress suture, even in the Finney pyloroplasty; I have never neglected to try to catch the submucosa, at least in two rows of sutures. In recent years I employ, when indicated, the continuous catgut suture to approximate the mucous membranes. We have gone over these cases again and again, from year to year, and there is not a single death from peritonitis due to leakage, except in a few instances where we were forced (or at least thought we were forced) to substitute catgut for silk. One of these cases was a resection of the cardiac end of the stomach, and the suture of the pyloric end to the œsophagus. On account of tension and operative shock demanding haste, I used catgut throughout. The patient died suddenly on the fifth day. At the autopsy we found peritonitis from leakage at a point where one catgut suture had pulled out. Since then I have learned to mobilize the duodenum making the Billroth I method possible after even an extensive resection of the stomach. We are always prepared for transfusion to meet shock. In this case I should have placed interrupted silk at least as the last row of sutures and thus covered the first two rows of catgut by approximating the stomach to the diaphragm. If this patient had not died because of the leakage, it would have been one of the first successful cases of resection of the cardiac end of the stomach for an extensive cancer with an end-to-end anastomosis between the pyloric end of the stomach and œsophagus. It is my opinion that I missed an opportunity by breaking away from Billroth's original procedure of three rows of interrupted silk. I am also of the opinion that Halsted's fine needles and silk rank first in safest intestinal suture today, in spite of the fact that many experienced operators are obtaining excellent results with two or three rows of continuous catgut.

Gastroenterostomy and Finney's pyloroplasty.—Apparently the first type of gastroenterostomy performed in Billroth's clinic was anterior and with a long loop, and it seems to have worked well (Fig. 11). The oldest illustration I have of Billroth depicts an entero-anastomosis. Following this was one of the most remarkable adventures in perfecting an intestinal suture of the lateral type and a gastroenterostomy, either after resection of the stomach for cancer or ulcer, or because of an inoperable cancer or ulcer, and, later, as an attempt to relieve or cure a duodenal ulcer. The first change in the gastroenterostomy was from an anterior one to a posterior, from antecolic to retrocolic. To perform an anterior anastomosis, whether ante- or postcolic, required a longer loop. The moment operators conceived the shorter route through a bloodless rent in the mesocolon, the loop became shorter and shorter, and the posterior wall of the stomach more accessible.

When I began to read the literature in 1893 and later to perform the operation, I was impressed most with the methods of Moynihan, of Leeds, England, and of William Mayo, in this country. I believe we owe to these two surgical geniuses the perfection of the short-loop retrocolic, posterior gastroenterostomy, and I have just had the opportunity to observe one of my

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own gastroenterostomies of this type made ten years ago. It has remained anatomically perfect.

As I read this literature and observe from the histories the recorded experience of my colleague Finney and my own, I am impressed that gastroenterostomy after resections of the stomach gave more immediate trouble and less remote trouble than gastroenterostomies without resection where the pylorus was patent. Here the perfection of the technic of Mayo and Moynihan practically obviated the immediate complication, but could not protect against subsequent formation of ulcer at the site of the anastomosis or the recurrence of the symptoms due to the gradual closure of the anastomosis. I remember distinctly that both, Doctor Finney and myself, looked upon a gastroenterostomy as an operation of necessity and not of choice. This undoubtedly influenced Finney in the conception and execution of the now well-known and well-established Finney pyloroplasty. From a historical standpoint, I would place Finney next to Billroth as the second great contributor to new methods in gastric surgery to be followed by Moynihan and Mayo because of their perfection of posterior gastroenterostomy. Then would come Polya and Balfour, because Polya's is now accepted as the best method of gastroenterostomy after resection of the stomach, and Balfour has made it safer by lengthening the loop, whether it is performed by the anterior or posterior route. The long loop, as shown first in Billroth's antecolic anterior gastroenterostomy (Fig. 11), practically avoided the great danger of duodenal dilatation.

Duodenal dilatation.—In November, 1907, when I published my article on acute and chronic dilatation of the duodenum, I was not familiar with the great danger of this complication when gastroenterostomy was performed with a short loop after resection of the stomach, and that most of these cases died, within five days, a duodenal death. But in the Journal of the American Medical Association for July 13, 1912 (pp. 59–117), I discussed the great danger of duodenal dilatation and its· fatality if there was any fault in the gastroenterostomy after resection of the stomach, and the chief cause of the kink was a short loop between the anastomosis and the duodenum, unless one fixed the stomach so that the anatomical positions would be maintained after operation, and not changed by rotation of the stomach, as shown in Fig. 3. The development of the Polya anastomosis and Balfour's modification proves this, although apparently those surgeons who were instrumental in the various modifications did not grasp the significance of duodenal dilatation.

What do the ultimate results indicate?—The immediate death after all forms of gastric surgery has practically been eliminated. No matter how sick the patients are before operation, or how anæmic, by better methods of anæsthesia and by blood transfusion, we are able to select the operation best for the lesion of the stomach irrespective of the condition of the patient. Now and then the operation may have to be done in two stages, but very rarely, in this country, is preliminary jejunostomy performed. Peritonitis

due to leakage, like death from shock, has practically been conquered by proper methods of suture. Nevertheless, the least danger after resection of the stomach seems to threaten when Billroth No. I end-to-end anastomosis is performed and when the Finney pyloroplasty is selected as a routine, if possible, instead of a gastroenterostomy. In spite of the remarkable success of the Polya-Balfour type of gastroenterostomy and the retrocolic short-loop posterior gastroenterostomy for duodenal ulcer, I am impressed, in studying the immediate and permanent results, that Billroth No. I, or the Kocher resection and Finney pyloroplasty, are methods of choice, while the others are methods of necessity. I venture to suggest, as based on personal experience, that for duodenal ulcer of a character forbidding Finney pyloroplasty, resection of the pyloric end of the stomach with the duodenal ulcer, followed by Billroth No. I anastomosis, be selected instead of posterior gastroenterostomy.

As to permanent results, I have before me resections of the Billroth No. I type, of the Kocher modification, resections with gastroenterostomy all the types, anterior and posterior including the Roux method, which we performed previous to the Polya and Polya-Balfour. There are also two ten-year cases of the Polya-Balfour type. Of all of these cases, we have X-rays of the stomach, and we know clinically that the function of the stomach is just about as good as that of the average individual of the same age who has not been subjected to operation. The function of the stomach is sufficient for enjoyment and proper nourishment. So far the only late risk is a possible peptic ulcer in the position of the gastroenterostomy, especially of the short-loop type.

If the patients live more than five years, the results seem to be the same whether the resection has been for cancer or ulcer, or for a few examples of gastroptosis.

The relation of gross and microscopic pathology to gastric surgery.—Palpation of the mass in the stomach may not distinguish the benign from the malignant lesion, but palpation by one experienced in diseases of the stomach will very quickly differentiate the mass that is suitable for resection with some chance of a cure if it is malignant. Without much doubt the easiest conclusion to make is whether the mass is resectable or not. The more difficult decision is whether resection should be attempted when the cure of cancer is practically ruled out for the reason that it promises the cancer case more comfort for the time the patient has to live than a gastroenterostomy, and the ulcer case a better chance for a permanent relief.

The removal of a gland near the stomach or in the omentum for immediate microscopic study does not exclude cancer if there is no metastasis, and does not contraindicate resection if there is metastasis. I have always followed the rule formulated more than twenty-five years ago by surgeons of the greatest experience—that resection of the stomach for malignant disease, if possible, offers the patient more comfort and perhaps lengthens the lives even when there is metastasis to the glands or to the liver. In some

instances it is justifiable to run the risk of increased operative mortality in order to obtain this greater comfort, even justifying resection of pieces of the pancreas and liver. In cases of this kind one can establish the exact diagnosis at once by excising a piece of the tumor, when there are no definite metastatic nodules for study.

Now that we have blood transfusion, I have personally extended the indications for resection in ulcer adherent to the pancreas or even to the liver. In the first place, you can establish the diagnosis by frozen sections. In ulcer there is often a line of cleavage which allows separation not present in cancer. This is especially true of large, adherent duodenal ulcers where resection is difficult due to adhesions to the pancreas and the jeopardy to the common duct. In cases of this kind resection offers so much more than gastroenterostomy for a permanent cure that in some instances it is justifiable.

I am convinced that skilled surgeons will improve their results in gastric surgery if they would personally study in detail the gross pathology of the specimen which they remove. It has helped me. In the first place, the careful post-operative pathological study will teach surgeons that it is unnecessary to give the cancer of the stomach so much margin, and the ulcer of the stomach may be given even less margin. This allows resection with a Billroth No. I anastomosis which today seems to be the operation of choice. In my clinic at St. Agnes, where the number of gastric cancers is relatively small, in the past two years we have been able to resect all the gastric carcinomas and then do a duodenal gastrostomy as first performed by Billroth. This knowledge of the gross pathology also encourages the operator to enlarge the field of resection for both cancer and ulcer. In recent years the number of the benign tumors of the stomach, especially of polypoid tumors, is increasing. A surgeon with pathological knowledge will be able to recognize these lesions.

The most difficult pathological problem is to distinguish the earliest stage of cancer in ulcer. On this decision hangs the percentage of five-year cures. After von Mikulicz's death, a re-study was made of his large material of gastric cancer in ulcer with the conclusion that quite a fair proportion of the lesions, diagnosed cancer and subjected to resection, were ulcers, and, of course, all of these cases had been included in the five-year cures. There will be border-line lesions in every organ until we have a differential stain for the malignant or cancer cell. Nevertheless, the study of the microscopic sections of the five-year cures in many clinics of this country is absolute proof that there have been some permanent cures after resection of the stomach for cancer. I have one such case now living twenty years since the operation. Every pathologist who has examined the section agrees to the diagnosis of cancer.

The next pathological problem is whether the microscopic study of sections helps us in proving whether cancer develops in ulcer. I do not believe that any pathologist will disagree with the statement that cancer does develop in ulcer of the skin and oral cavity. But you cannot prove it, or

you can prove it, by microscopic interpretation just as decidedly as in ulcer of the stomach. Yet many pathologists are of the opinion that cancer rarely develops in ulcer of the stomach. This controversy which has often been unpleasant has detracted from, rather than added to, our progress in the control of cancer of the stomach.

SOME ILLUSTRATIVE CASES. (*Billroth No. I.*)—In the first place, I am reproducing an illustration from Billroth's Clinical Surgery, published in 1876. In this the various diagrams picture a cancer of the pylorus (Fig. 1). Note the significance of the small tumor. This is the type that Kocher, after twenty-five years of experience, found to be the most frequent among the five-year cures—freely movable, small masses at the pylorus. Note the small margin given the tumor by Billroth. My five-year cures had no larger margin. Note the absence of clamps. Note the various types of end-to-end anastomosis between duodenum and stomach. How beautifully are pictured the interrupted silk sutures in three rows! I question if there has been any improvement in the conception or execution of this operation upon the stomach since Billroth. Although the literature is before me now as I dictate, I will not take the space in this preliminary report to discuss it. But I will simply emphasize again that the trend of recent surgery is towards Billroth No. I. It can easily be combined with the complete excision of the glands along the lesser and greater curvatures, and by mobilization of the duodenum, one can almost suture the duodenum to the œsophagus, if necessary. I have no evidence and I can find no evidence that removal of the glands along the lesser or greater curvature of the stomach accomplishes a cure when they are involved. Now that our technic is so safe there is no objection to trying it.

CASE I.—Pathol. No. 5437. Operation in 1904. *Resection for ulcer of the lesser curvature.* Suture Billroth No. I. Well in 1930.

Figure 4 shows an X-ray of the stomach of this patient (Lachner) taken by my colleague, Doctor Kahn, March 18, 1930. The patient has had no symptoms since his operation twenty-six years ago. You will observe there is no duodenal cap between the stomach and the duodenum, and it is a much more normal picture than after a Finney pyloroplasty or a Kocher. This case was reported in detail in the Johns Hopkins Hospital Bulletin (vol. xv, No. 164, November, 1904). Figure 5 pictures the ulcer on the lesser curvature, the dotted lines, the area resected without clamps. Figure 6 is a diagram of the sutured lesser curvature of the stomach and the gastro-duodenostomy. Dr. William A. Fisher, then resident surgeon of the Union Protestant Infirmary, assisted me. The sutures were made with fine black silk and fine straight Halsted needles. We inverted so much in the end-to-end suture that very little passed through into the duodenum for ten days. Figure 7 shows the typical gross ulcer. It was microscopically benign. I am inclined to think it pictures an acute ulcer of the stomach which would have recovered under rest and ulcer treatment. The patient, a white male, aged thirty-three, had had symptoms for only three weeks—constant, distressing, epigastric discomfort and watery vomiting at night. This man worked in the hottest furnace rooms at Sparrows Point near Baltimore. He has been in the same environment since the operation, and there has been no recurrence of the symptoms. It is natural to ask the question whether this resection, changing hyperacidity to hypo-acidity, has protected from recurrence of the ulcer.

FIG. 4.—Pathol. No. 5437.— Case 1. Text, p. 6. X-ray by Doctor Kahn, twenty-six years after resection of the stomach for ulcer with Billroth No. I anastomosis. Note silver wires in right rectus incision. Note the new pyloric ring without cap. Duodenum seems dilated. Patient free from symptoms.

FIG. 8.—Pathol. No. 10763.—X-ray by Doctor Kahn, April, 1930, twenty years after resection of stomach for freely movable cancer of pylorus, with Kocher anastomosis, as shown in Fig. 2. Compare this with Fig 4, X-ray after resection Billroth No. I. Patient free of gastric symptoms, holds weight.
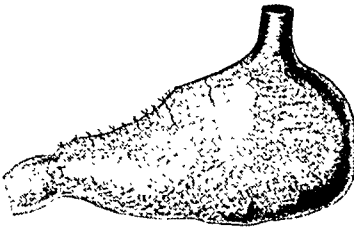
FIG. 6.
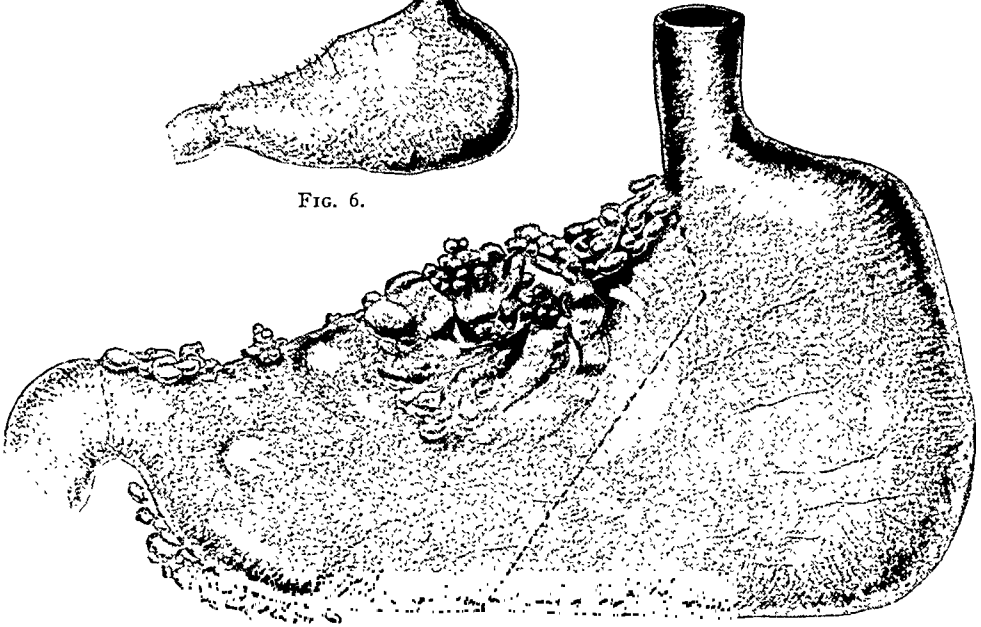
FIG. 5.

FIG. 5.—Pathol. No. 5437.—Sketch by Miss Hayes of position of ulcer resected through dotted lines in 1902. See Fig. 6 for Billroth No. I suture, and Figs. 7 and 7A for gross appearance of ulcer.

FIG. 6.—Pathol. No. 5437.—Sketch of suture (Billroth No. I) after resection shown in Fig. 5. See text, p. 17.

Case II.—Pathol. No. 39150. Resection Billroth No. 1, April, 1927. Well, May, 1930. three years.

This case was fully reported with illustrations in the Practice of Surgery, edited by Dean Lewis (vol. vi, ch. 8, Figs. 25 to 29, pp. 88 to 92). This man has perfect gastric function. There are two very important observations in this case. In the first place, when this patient was studied clinically and the mass in the upper abdomen palpated and the X-ray plates studied, in the greatest gastric clinic of the world, the diagnosis was "inoperable cancer of the stomach," and even exploratory laparotomy was decided against. Nevertheless, at the operation, I found a freely movable mass, much larger than a man's fist. But the stomach was large and almost two-thirds of the gastric portion of the stomach free of disease. The mass was easily resected. The next most important point is the narrow margin we purposely gave the new growth. There was no difficulty in performing a gastro-duodenostomy (Billroth No. I). No clamps were employed. The
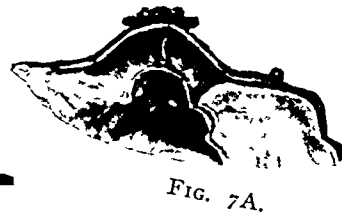
Fig. 7A.

Fig. 7.

Figs. 7 and 7A.—Pathol. No. 5437.—Painting of actual specimen removed as shown in Fig. 5, mucous membrane surface showing ulcer with distinct sharply cut edge. The depth of the ulcer is shown in Fig. 7A.

entire suture was performed with fine silk—three rows interrupted. The gross specimen shows the abrupt ending of the cancer. Microscopically, it was a low-grade colloid cancer. I explored the abdomen, because my studies of gastric cancer and ulcer have demonstrated that the only definite hopeless signs are nodules in the abdominal wall and free fluid in the peritoneal cavity. All other signs are not positive. This is not the first case apparently inoperable from the X-ray and palpation that we have been able to resect, but it is the first patient to live so long after operation.

Gastro-duodenostomy: Kocher's anastomosis.—The only surgeon whom I have seen perform Kocher's anastomosis was Dr. William J. Mayo. My associate, Dr. L. Clarence Cohn, has reported our experience with this method of resection and suture in the Annals of Surgery for February, 1924. This operation was first performed by us in 1910, and since 1924 we have changed back to Billroth No. I. Doctor Cohn illustrates the photo-

graphs of the gross specimen and microscopic appearance of a cancer at the pylorus resected by me at St. Agnes Hospital in 1910. This patient is living and free from symptoms in 1930.

Figure 8 (Pathol. No. 10763) is an X-ray taken by my colleague, Doctor Kahn, of this patient (Mr. Eakle), in April, 1930. It should be compared with Fig. 4, a post-operative X-ray twenty-six years after a Billroth No. I, and you will see that it is almost identical with Fig. 9; an X-ray ten years after a resection of the pyloric end of the stomach and a Kocher anastomosis. And these figures, 4, 8 and 9, should be compared with Fig. 10, a post-

FIG 9 —Pathol No 12058 —X ray ten years after resection of pylorus for chronic duodenal ulcer followed by Kocher's anastomosis Compare with Fig 8, same type of anastomosis after resection for cancer Both patients have no gastric symptoms See text, p 21

FIG 10 —Pathol No 24026 —X ray September 25, 1924, five years after resection of cancer of the greater curvature near pylorus Compare with Figs 4, 8 and 9 The duodenal shadow is different The patient is free of symptoms See text, p 20

operative X-ray six years after resection and Kocher anastomosis. Why does Fig. 10 look different from Figs. 8 and 9? The operation in Figs. 8 and 9 were identical—both resections of the pyloric end of the stomach. The lesions removed in Fig. 8 was cancer, in Fig. 9 a chronic duodenal ulcer, while the lesion in Fig. 10 involved the greater curvature of the stomach, so that the resultant form of the end of the stomach anastomosed to the duodenum was different from that in Figs. 8 and 9.

Pathol. No. 24026.—See Fig. 10. This case is the first, or one of the first five-year cures after resection of a cancer involving the greater curvature of the stomach near the pyloric end of the stomach. It is now eleven years since the operation, and the patient is free from symptoms. As a cured case of resection for cancer of the stomach, it is apparently unique in the fact that the cancer was adherent to the abdominal wall, and a large piece of the abdominal wall was excised with the tumor. The local pain and

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tenderness referred to the left and below the umbilicus at the point of adhesion of five months' duration, was apparently responsible for bringing the patient earlier to the attention of Doctor O'Mara, chief of the medical clinic at St. Agnes Hospital. There were no other symptoms, except nausea before meals, relieved by food. The glands, although enlarged, showed no metastatic cells.

Mr. George Thompson, member of the third-year medical class of Johns Hopkins University, a research student of the Garvan Experimental Fund in the Surgical Pathological Laboratory of the Johns Hopkins Hospital, has written to, and seen, every patient recorded in the laboratory living today whose operation has been either a Kocher or a Billroth No. I after resection for cancer, gastric or duodenal ulcer, and in every instance, clinically, the patients are free from symptoms irrespective of the pathology of the lesion which had indicated the operation. As stated before, we found the Billroth No. I suture just as safe as the Kocher, and Billroth No. I can be performed when Kocher would be difficult on account of the size of the remaining stomach.

I call attention to a small group of chronic duodenal ulcers, usually posterior and adherent to the pancreas, absolutely unsuitable for the Finney pyloroplasty, or any form of gastro-duodenostomy, which were not relieved by a posterior gastroenterostomy. In my limited experience, these cases are permanently relieved by resection, even with a portion of the pancreas, and a Kocher or Billroth No. I anastomosis. Figure 9 is an example of such a case.

Billroth No. II: gastric resection with gastroenterostomy.—Figure 11 is a photograph from an illustration in Billroth's Surgery made more than forty-five years ago. It pictures the long loop, anterior gastroenterostomy with an entero-enterostomy. Notice, in this picture, the unnecessary margin of uninvolved stomach given the tumor in this case. Compare it with Fig. 3, a photograph of a modern short-loop, posterior gastroenterostomy. I have already discussed that the short-loop gastroenterostomy of any type after resection of a portion of the stomach with a closed duodenum, runs, first, the risk of death due to duodenal dilatation; second, the risk of a partial kink from which there is no complete recovery until to the gastroenterostomy is added entero-enterostomy; and, third, secondary peptic ulcer at the anastomosis. I have before me now cases of five or more years' duration in which the operation was resection with Billroth No. II and a short loop. It is in this group that I find a certain per cent. of the three complications just mentioned—complications which we have never observed after resection of the stomach followed by a Kocher or Billroth No. I anastomosis. True, there have been some perfect results in which there have been no complications seventeen and nineteen years after operation. Since that date, 1913, I have practically given up a short-loop gastroenterostomy of any type after resection of a portion of the stomach, and in the few cases that I have been

unable to perform the Billroth No. I, the Polya method as modified by Balfour has been used with excellent results.

In the Practice of Surgery, edited by Dean Lewis (vol. vi, ch. 8, Fig. 1) there is illustrated the case of a huge ulcer of the stomach, the largest we have ever resected, in which the patient is free from symptoms today twenty years after resection and a Billroth No. II anastomosis.

Gastro-jejunostomy: Roux type.—About twenty-two years ago I performed a huge resection of the stomach for ulcer. At operation I could not be certain whether it was ulcer or cancer. There was no particular difficulty in the resection, but the remaining cardiac end of the stomach was so
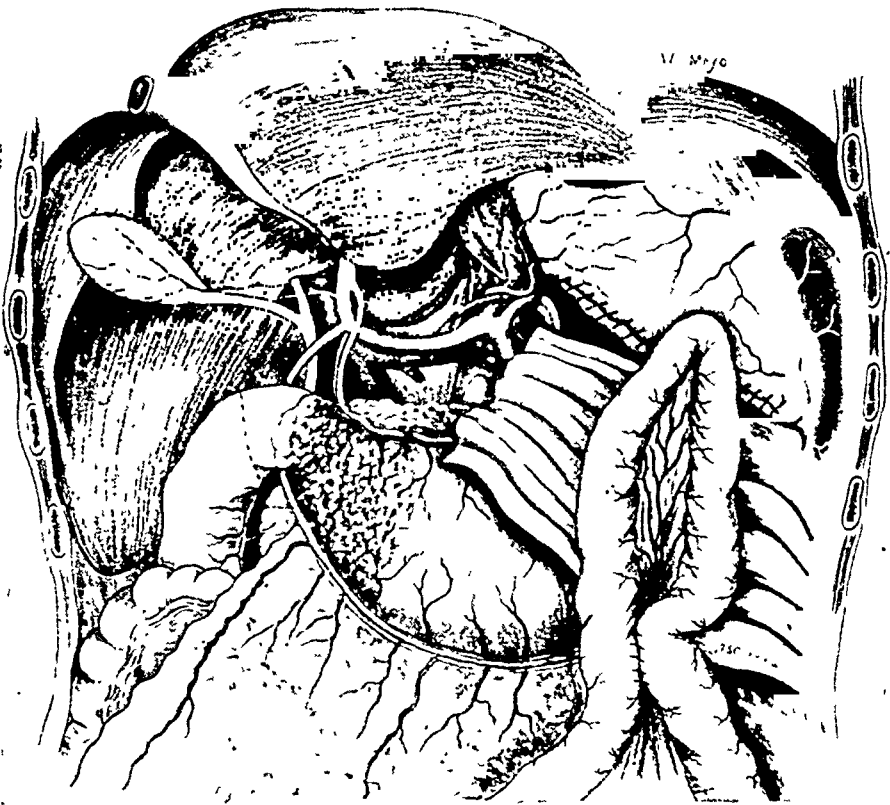
FIG. 11.—Copied from B'llroth's Clinical Surgery, 1876. Reproduced by William J. Mayo to illustrate long-loop antecolic anterior gastroenterostomy with jejunojejunostomy. Note continuous suture ins'ead of interrupted shown in Fig. 1; wide margin of uninvolved stomach wall as compared with narrow margin in Fig. 1. From this sketch it is my opinion a narrower margin would have allowed a Billroth No. I anastomosis.

small that I did a short-loop gastro-jejunostomy, Roux type, retrocolic. There would have been no difficulty whatever in performing the long-loop anterior gastroenterostomy, as pictured in Fig. 11. This patient died of acute dilatation of the duodenum. In 1911, I was confronted at operation with what was apparently a duodenal ulcer with such extensive adhesions that it was impossible to lift up the transverse colon and perform a retrocolic anastomosis. I therefore chose a long-loop Roux gastro-jejunostomy, anterior. This patient is living and free of symptoms today, nineteen years later. I

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may be able to add the post-operative X-ray which shows both the pylorus and the anastomosis working.

Resection: gastroenterostomy of the Polya type.—I have before me two histories in which the operation was performed for gastric ulcer by my colleague, Dr. Emil Novak, at St. Agnes Hospital, seven and eight years ago. One patient operated on seven years ago reports well. The other patient writes, "I am not well, but at the present time I am not under the care of a physician." We do not know whether the symptoms she is suffering from have any relation to her former condition or the operation.

My first experience with the Polya-type gastroenterostomy was ten years ago. I followed exactly the directions of the author. The loop was more or less short and the anastomosis retrocolic. The patient died suddenly on the fifth day from embolism without gastric symptoms.

The second operation was performed in October, 1928, on a thin woman, aged eighty-two. The lesion was cancer at the pylorus, which had infiltrated the pancreas and could not be completely removed from the pancreas. This form of anastomosis was chosen because I did not wish to make a Billroth No. I gastro-duodenostomy over the raw surface of pancreatic tissue and cancer. In this second case, using Polya, I chose the modification of Balfour, of the Mayo Clinic, in which the loop is longer and the anastomosis is anterior. There has been recently reported from Sweden a peptic ulcer following this method of anastomosis.

Posterior gastroenterostomy without resection of the stomach for gastric ulcer.—Apparently Doctor Finney and myself agree that any form of posterior gastroenterostomy without resection is an operation of necessity and not of choice.

I have never seen death from acute dilatation of the stomach after gastroenterostomy of any type, even the short-loop posterior. But every surgeon knows that it may fail to cure the gastric or duodenal ulcer. In a few instances, especially when the operation is badly done, it may lead to chronic dilatation of the duodenum which may be relieved by duodeno-jejunostomy as a secondary procedure. I will take this opportunity to quote a few cases of successes and failures.

Pathol. No. 8923.—I explored the abdomen in 1908, twenty-two years ago, because of symptoms we thought then typical of gastric ulcer. No ulcer was found; the gall-bladder was drained. Seven months later the patient returned with even more exaggerated symptoms, and at the second operation we found a large indurated mass in the lesser curvature of the stomach adherent to the liver, suggesting walled-off 'perforation. There were no signs or symptoms of obstruction at the pylorus, at either operation. In 1914, five years later, at an operation for ventral hernia, all the evidence of gastric ulcer had disappeared. The posterior gastroenterostomy was working.

Pathol. No. 9174½.—*Posterior gastroenterostomy* at St. Agnes Hospital in 1909, twenty-one years ago, for gastric ulcer. Symptoms were absolutely relieved. The clinical picture before operation suggested chronic cholecystitis. The gall-bladder attacks had been present over two months; jaundice in one attack. There was gastric residuum 136 cubic centimetres; total acid 32°; free hydrochloric acid 32°. At the operation we found

on the anterior side of the pylorus midway between the greater and lesser curvature a distinct dimpling of the peritoneum with a zone of induration the size of a fifty-cent piece beneath. The pylorus was patent and the stomach not dilated. The indurated area extended in to the duodenal wall. There were adhesions between the duodenum, stomach and gall-bladder. This patient writes that he has been completely relieved of all symptoms for twenty-one years. I am inclined to the diagnosis of duodenal ulcer.

Pathol. No. 10778½.—*Posterior gastroenterostomy, short loop, for extensive gastric ulcer with adhesions.* The patient is well in 1930, nineteen years later. She was relieved at once. At the operation we found a huge stomach, marked induration of the pyloric end of the stomach extending into the duodenum with adhesions to the gall-bladder. The operative diagnosis was ulcer rather than cancer. Had it been cancer it would have been inoperable. There was a long history of indigestion with partial gastric obstruction; an operation two years before with drainage of the gall-bladder.

I asked Mr. Thompson to simply gather for me the patients who were living five years or more after any operation for gastric or duodenal lesions, and I have mentioned only one or two in which the operations were less than five years ago. I have not taken up the total number of operations in each group, because I wished to present the picture from cases living, irrespective of disease, operation or present result. With few exceptions the fact is brought out that if they live five years or more they are free from symptoms.

That Mr. Thompson could find but three cases of short-loop posterior gastroenterostomies for gastric ulcer living five years or more after operation, simply shows that I rarely perform this operation for gastric ulcer, always trying resection if possible. But these three cases demonstrate that posterior gastroenterostomy can be performed and the patient live seventeen years or more, apparently relieved of their symptoms and not given any discomfort by their gastroenterostomy. Only the first case was a positive gastric ulcer; the second may have been a duodenal ulcer. The picture in the third case was confused by the previous operation.

There is quite a large number of gastroenterostomies for inoperable cancer that were temporarily relieved, irrespective of the type of the anastomosis, but none lived five years.

Posterior gastroenterostomy for duodenal ulcer.—The majority of surgeons choose this operation, and the results are uniformly good. Very few surgeons select a group for the Finney pyloroplasty. When I compare my own results I find that I have had the same satisfactory relief after both, the Finney pyloroplasty and the gastroenterostomy for duodenal ulcer, except in cases unsuitable for the Finney operation, but with extensive adhesions and a posterior ulcer adherent to the pancreas. And as I have practiced resection largely in this type, the operative results for duodenal ulcer have been uniformly good. I will briefly review these successes and failures here.

Pathol. No. 17044.—*Short-loop posterior gastroenterostomy* for duodenal ulcer in 1915. Relieved of symptoms and well in 1930, after a period of fifteen years. This adult male, aged fifty, had had symptoms fifteen years. He was under continuous and efficient medical treatment by Doctor Mizell, of Atlanta, Ga., for three years. The marked symptoms are periodic recurrent attacks of pain, indigestion relieved by induced vomiting and lavage. Before seeing the pylorus I could feel that it was obstructed and could palpate

the induration on the duodenal side. Pylorus, gall-bladder, pancreas, transverse colon were bound into one mass which was hard. I could not tell whether it was cancer or inflammation. As it seemed chiefly duodenal, duodenal ulcer seemed the reasonable diagnosis, and posterior gastroenterostomy not only the operation of necessity, but of choice. The adhesions were entirely too extensive to justify resection, even today, with my accumulated experience of fifteen years. This patient was immediately relieved, and yearly reports from Doctor Mizell read as follows: "Yes, well, except for some duodenal or pyloric irritations from coarse food which he eats at occasional periods."

Pathol. No. 17640.—*Posterior gastroenterostomy for duodenal ulcer* in 1915. The patient writes that he is well in 1930, fifteen years after operation. I performed this operation with Doctor McQueen at his hospital in Charlestown, W. Va. The symptoms had been present twenty-one years and were typical. They were complicated by the excessive use of alcohol. At the operation, the omentum and greater curvature of the stomach on the pyloric third of the stomach were adherent to the liver for a distance of seven centimetres to the left of the notch. This pulled the stomach up. When we had separated these adhesions, we found the gall-bladder adherent. Finally we exposed the pylorus and duodenum. The pylorus was not contracted. On the anterior side of the duodenum, in about the second portion, there was an indurated mass which was the centre of all the adhesions, and every one contracted to this point. It was about the size of the end of the index finger. It was near the common duct. (Twelve years ago there had been an attack with jaundice.) We separated only enough adhesions to make certain of the duodenal ulcer and that a Finney pyloroplasty or resection was too difficult for the operation of choice. This patient was immediately and permanently relieved in spite of the fact that the alcohol history remained about the same.

Pathol. No. 17722.—Fifteen years ago, at St. Agnes Hospital in 1915, this adult male was operated upon by a posterior retrocolic gastroenterostomy for duodenal ulcer, and was immediately and permanently relieved up to date (1930). At first there was no palpable or visible duodenal ulcer. There were no adehsions, but the peritoneum over the duodenum and above the pylorus was covered with scar tissue extending to the common duct and gall-bladder. The pylorus was slightly contracted. The absolute position of the ulcer could not be found. These findings made the Finney pyloroplasty unsuitable and seemed not sufficiently marked to justify resection and Billroth I. This man, aged twenty-eight, complained of symptoms of indigestion for six months. They began on an empty stomach and were relieved by food, but the relief was only temporary. He was underweight and when carefully questioned complained that he had had a bad appetite for five years since emigrating from Ireland to this country. Then he admitted attacks of indigestion for many years. In the last six months there have been attacks of vomiting of blood and blood in the stools.

In these cases I am not discussing the X-ray studied before and after operation, taking space to emphasize the relation between the operative result and the pathology, and the duration of the symptoms.

Pathol. No. 17774.—This male, aged fifty-five, had had recurrent abdominal attacks for fifteen years, and the operation of posterior gastroenterostomy was performed in 1915. The patient and his doctor report him well in 1930. He was brought to Baltimore by Doctor Parker, of Greenville, S. C., and had been acutely ill for five days. He was operated on at once, because there were symptoms of perforation, but not of peritonitis. It is very important to note that this patient went through an efficient study by a surgeon and gastroenterologist five weeks before the perforation, and at that time was advised to go home with the statement that no operation was indicated. The diagnosis was not duodenal ulcer, but chronic appendicitis. When I opened the abdomen I could see blood in the small intestines. In the region of the duodenum, beginning at the pylorus and occupying a part of the first third of the duodenum, we could see fresh exudate extending over the pylorus, duodenum to liver, and within this a palpable mass. I felt it unwise to disturb this area as it suggested a walled-off perforation and, undoubtedly, had we

exposed the perforation, it would have been difficult to suture. For this reason we drained to this area, and performed a posterior gastroenterostomy.

On opening the stomach and jejunum I found bile and blood. After operation there was no further bleeding. When the drains were removed there was no evidence of perforation or abscess.

Pathol. No. 20746.—This was the first woman among these five cases of posterior gastroenterostomy to be immediately and permanently relieved of definite duodenal ulcer. The patient was fifty-seven years of age, having had definite symptoms for fifteen years. The frequent vomiting suggested pyloric stenosis. She had lost one hundred pounds of her two hundred forty pounds of weight. There had been no bleeding. The X-ray was typical of stenosis. At the operation, a film of scar tissue covered the duodenum and pylorus, binding it down. There was also the same scar tissue between the duodenum and the gall-bladder. The pylorus was almost closed. It seemed unsuitable for a Finney pyloroplasty. Her physician, Doctor Wagaman, of Hagerstown, Md., writes in 1930 that the patient is well.

It is to be noted that in none of these five cases was the pathology suitable for a Finney pyloroplasty, nor did it seem justifiable to try resection.

These results after posterior gastroenterostomy for gastric and duodenal ulcer should be borne in mind. There is no doubt that in every clinic among operators who understand this operation immediate and permanent relief can be obtained if the cases are properly selected, and even when resection does not seem feasible or proper at the first operation because of the added risk, posterior gastroenterostomy can be done first and the patient carefully watched. If not relieved, resection can be attempted later.

Pathol. No. 23791.—*Apparent failures after posterior gastroenterostomy.* In this instance the posterior gastroenterostomy performed in 1918 for chronic duodenal ulcer in which there was a mass adherent to the pancreas, failed to completely relieve the patient. Twelve years later, in 1930, the patient came under observation and claimed that he had never been relieved of his symptoms. We found that the anastomosis was practically closed and as there had been no active symptoms and no hæmorrhage, only indefinite attacks of indigestion, and as the X-rays showed a patent pylorus, we simply detached the jejunum from the stomach, because it was of no value, and had a minute peptic ulcer at the side of the opening which would not admit the little finger. The adhesions noted at the first operation twelve years before seemed to be less. We could see the pylorus and duodenum. The pylorus was patent. I apparently overlooked at the second operation the mass in the posterior wall of the middle third of the duodenum adherent to the pancreas. This operation was on November 22, 1929. I operated upon this patient a third time on April 10, 1930, about four months later, as the operation had not relieved him of his discomfort and because there had been bleeding to an extent demanding three blood transfusions. The patient's condition was such that we selected a rapid anterior gastroenterostomy. This operation relieved the patient of his symptoms and the bleeding ceased, when suddenly on the fifth day he died with symptoms of embolism. An autopsy was not allowed.

A few months before and a few weeks after observing this failure of a posterior gastroenterostomy, I had similar cases who were in good shape at the time of operation and in which I resected a small piece of the stomach, the pylorus, the duodenum with its ulcer and a piece of pancreas, and then anastomosed the duodenum to the stomach by the Billroth No. I method. Both of these patients were relieved immediately and permanently by the

operation. One of them who had tuberculosis at the time of the operation died some months later of tubercular pneumonia, which seemed to be due to an attack of grippe rather than a post-operative sequence. The operation was performed under local anæsthesia. There are other cases in this group which I will discuss in greater detail when I report Pathol. No. 23791. But this case stands out as a distinct failure of posterior gastroenterostomy to relieve a certain type of chronic indurated duodenal ulcer. Unfortunately this patient was of a peculiar mental disposition. None seemed to pay attention to his complaints, and he did not come back to see me until he was desperately ill. I am chagrined that I did not recognize that the chronic ulcer was still present, because at the operation in November, 1929, the patient's condition would have justified resection.

Pathol. No. 13505.—In this case it seemed to be the adhesions present before operation that kept the patient uncomfortable. The three operations for adhesions between November, 1912, and April, 1915, gave only temporary relief. The adhesions originally were apparently the result of a healed duodenal ulcer. In 1915, posterior gastroenterostomy was performed as a last resort. In 1923, the patient reported "no better" after a continuous observation of nine years. However, in 1930, seven years later, he reports well.

I find notes on about six cases in which the operation consisted of separation of adhesions around the gall-bladder and in which we could find no indication for removal or drainage of the gall-bladder, posterior gastroenterostomy or Finney pyloroplasty.

Pathol. No. 13505 represents the single failure among this group. Pre- and post-operative adhesions explain, in a certain number of cases, uncomfortable symptoms with and without obstruction which may follow any laparotomy. It is not a large group, but it is a very difficult one to handle. Time is an important element in recovery, and unless there are symptoms of obstruction or unless there is a definite hernia, they are better left alone.

Pathol. No. 25554.—Here is an example of a faulty gastroenterostomy performed under the diagnosis of chronic duodenal ulcer. This patient was relieved of her symptoms, of intermittent attacks of vomiting and continuous abdominal distress and ill-health which had been present fifteen years, by a duodeno-jejunostomy and resection of the right colon. It is now ten years since that operation. In the history, difficult to obtain, one gets the impression that this patient, when she was operated upon in 1905, had ptosis of the stomach and colon. The operation was performed by a surgeon of practically no experience in gastroenterostomy. She claims that there were three operations within a short period of time, and she was gradually getting worse in the fifteen-year interval. After a thorough study in 1920, with Doctor Freeman, we decided that her chief trouble was a faulty gastroenterostomy. The most marked feature was intense attacks of pain and vomiting.

When we opened the abdomen in 1920, we had to remove the adherent omentum before we could expose the region of the gastroenterostomy. In spite of the adhesions of the upper portion of the jejunum, we could make out that the posterior gastroenterostomy had been performed with a long loop, and there had been at least one entero-anastomosis. In spite of pre-operative preparation and starvation, some of these loops were still dilated. There had also been a suspension of the uterus which was not disturbed. The right colon was so bound down by adhesions that I felt that this right colon should be resected first. Then we brought to view the huge dilatation of the duodenum. A loop of jejunum, free from adhesions below the faulty gastroenterostomy and adherent loops, was anastomosed to the duodenum, later method. There was no difficulty whatever. We divided the peritoneum over the duodenum, made the anastomosis and then sutured the edge of the

peritoneum to the duodenum. Now the ileum was sutured to the transverse colon by the lateral method. The patient, today, ten years later, is not a perfectly healthy or well woman. She still has her intermittent headaches and nervousness, but her vomiting attacks have been relieved, and she has much less indigestion. In this instance, therefore, there was not only a faulty gastroenterostomy, but there was no evidence that there had been any indication for this operation.

Finney pyloroplasty.—My association with Dr. John M. T. Finney, both at Johns Hopkins and the Union Memorial Hospital, brought me in close touch with his new method of pyloroplasty. I could not find a single case in which the operation failed to relieve the patient. There have been no examples of re-operation or recurrence of symptoms. In 1926, I selected for the first case one in which heretofore I should have performed posterior gastroenterostomy. The ulcer was distinctly palpable, but the pylorus and stomach were so movable that there was no more difficulty in easily performing the posterior line of sutures than opening the pylorus, stomach and duodenum and demonstrating by finger and eye an ulcer about one centimetre in diameter. It was on the posterior wall of the first portion of the duodenum. It was excised with an endothermy needle down to the scar on the peritoneal side and then closed with interrupted silk in the mucous membrane and mucosa. Such ligatures different from the continuous silk and not buried are discharged spontaneously after ten to twelve days. This patient has remained well (1930) four years since the operation.

In 1929, I performed a second operation of this type which has so far been successful.

My first Finney pyloroplasty was in 1902. At that time there was much theoretical discussion about gastroenterostomy as a drainage operation, and that it should be performed at a point in the stomach where drainage would be best. This patient had a huge dilated stomach because of a ring contraction or hemosis, at the pylorus. He had been using a stomach tube for more than ten years, and had been a patient on the medical service of Johns Hopkins for more than four years. Doctor Corss, of Newport News, Va., asked me to come there to operate as the patient was starving to death and had reached ninety pounds. At the operation there were no adhesions, no signs of ulcer of stomach or duodenum. The Finney pyloroplasty did not answer the requirements for drainage at the most dependent part, but it seemed the simplest, quickest thing to do. The man was immediately relieved and has remained so ever since. He has gained in weight.

Doctor Finney, who has had a very much larger experience during these twenty-eight years, has made a full report which will appear in the Transactions.

Among the cases operated on by Finney, I know of only two unfavorable results—in one the operation was performed for chronic duodenal dilatation, and the patient died within five days of acute dilatation of the duodenum. ANNALS OF SURGERY, (vol. xlvi, p. 736, 1907), reported again the Journal of the American Medical Ass. (vol. lix, p. 117, July 30, 1912). In the other

case, after relief of some years by Finney pyloroplasty, there was recurrence of the symptoms and posterior gastroenterostomy was performed with relief up to the present time.

One who reads the literature, listens to the discussion by surgeons of experience, and studies his own cases critically, knows that today, in the majority of instances, if the surgeon is well trained and the operation selected which experience has taught us to select as based upon the operative findings, there will be a very low operative mortality and few failures. The chief failures will be in cancer, and the cause will be the disease and not the operation. I, however, wish to call attention to the fact that the operations which promise the least chance of post-operative troubles are resections of the Kocher and Billroth No. I type and the Finney pyloroplasty, or some type of gastro-duodenostomy, practiced by Horsley, of Richmond, and others.

Finney pyloroplasty, or some type of gastro-duodenostomy with resection of the ulcer, can be pushed too far, and one must learn when it is safer and more certain to either perform posterior gastroenterostomy or resection with Billroth No. I suture.

I have a case under observation now. The operation was performed by one of our most experienced surgeons. The patient has not been relieved. There is still some obstruction, the patient is underweight and unable to take sufficient food to gain weight.

Perforation.—As William Mayo states, the dangers of perforation and hæmorrhage have been exaggerated. Nevertheless, it is still possible. I have already noted in this paper an example, in which the patient was carefully studied by an unusually experienced surgeon and gastroenterologist and sent home, only to return within a week with a walled-off perforation. Ten years ago we were having a conference in my office and about eleven o'clock at night one of my associates, who had been in the laboratory for more than one year, told me about his digestive symptoms. There was nothing in them to suggest impending perforation or hæmorrhage, nor obstruction, but enough to arouse suspicion of an ulcer, probably duodenal, enough to justify immediate rest in bed and starvation diet, while studies were made to see if operation was indicated. He consented to go to the hospital in the morning. He arrived eight hours later with perforation and died in spite of immediate operation, because his stomach contents held the hemolytic streptococcus.

There are four duodenal perforations which have been free of symptoms sixteen to fourteen years after operation, without recurrence of symptoms, hæmorrhage, perforation or obstruction. In three cases the perforation was simply closed. All were apparently acute ulcers. In one the small chronic ulcer was excised. I have never, in free perforation of a duodenal ulcer, performed either the Finney pyloroplasty or gastroenterostomy, and there have been no re-operations.

Hour-glass stomach.—There is but one case in which five years or more have elapsed since operation. In this instance, in 1920, a band of adhesions

producing an hour-glass contraction between the mid and cardiac third of the stomach was divided, and the patient is apparently well today, ten years later. Here there was a distinct history of ulcer of the stomach. Apparently, the ulcer was at the lesser curvature, and during the acute stage the adhesions had formed.

CONCLUSIONS

I urge the more frequent choice of the Billroth No. I anastomosis after resection of the stomach, pylorus or duodenum. In resection for cancer, it is unnecessary to give the wide margin of an uninvolved wall. When Billroth No. II must be performed, I would urge a long-loop gastroenterostomy and would recommend Balfour's modification of Polya's operation. In duodenal ulcer the Finney pyloroplasty is the operation of choice, if local conditions allow it, with and without the local excision of the ulcer. When Finney pyloroplasty is contraindicated, there must be a choice between short-loop posterior gastroenterostomy and resection.

In large chronic ulcers of the duodenum, especially those adherent to the pancreas, I advise resection rather than posterior gastroenterostomy. Finney's pyloroplasty or any type of gastro-duodenostomy with local resection of the ulcer may be carried too far. In such cases either a posterior gastroenterostomy, resection and Billroth No. I should be the operation of choice. It is rarely necessary when operating for a perforated duodenal ulcer to do more than to close the perforation and drain. Do not diagnose inoperable carcinoma from palpation and X-ray alone. Give the patient the benefit of exploration, unless there are skin metastases or fluid in the peritoneal cavity. And even then, if there is obstruction, operation is indicated.

Postscript.—I wish to call attention to the importance of making X-ray pictures after all gastric operations so that we may learn the varying normal as shown in Figs. 4, 8, 9 and 10. Five years ago a patient of mine, upon whom ten years previously I had resected the stomach and performed a Kocher anastomosis and with this resected the right colon for ptosis, had symptoms of indigestion, and, as I was in Europe, went to one of our best gastro-intestinal clinics and was diagnosed cancer from the X-ray picture. His X-ray picture, as I recollect it, resembled that shown in Fig. 10. But so far we have been unable to find the X-ray taken at either clinic. The patient lived four years and died of flu-pneumonia. The resection of the stomach was performed because of stenosis from a kink and a huge dilated stomach. It relieved the symptoms. The indigestion which caused the X-ray was a temporary affair and had relieved itself before I saw the patient. I have reported this case on two occasions when we have discussed the treatment of ptosis of the stomach and colon. The patient represented the best result I have ever obtained in the operative relief of ptosis of the colon and stomach. Some operation was imperative on the stomach, because of pyloric stenosis. I chose resection rather than Finney's pyloroplasty simply to get rid of the huge dilated stomach which was in the way, and made resection of the right colon more difficult.

A FOLLOW-UP STUDY OF THE RESULTS IN SURGICAL THERAPY FOR GASTRIC AND DUODENAL ULCER

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In the study of a disease in which the etiology is not known, and therefore in which the consideration of the best of many forms of therapy is in a state of controversy one premise stands out clearly, viz., that effort should be concentrated on investigation of cause. But until such time as the cause is known and the resultant treatment established, the soundest method of approach in actual therapy must be based on honest evaluation of results obtained by present methods. This is only possible by follow-up study.

When one attempts a review of the mass of European literature one is impressed by the frequency of the expression of the opposite viewpoint, viz., emphasis on technical procedure and paucity of evidence of detail study of interval and late results. For example, recently there have appeared reports from two of the best-known European clinics as follows: The first, a report of over one hundred radical resections for ulcer with the note that "ninety-eight per cent. were entirely cured after three to fifteen years," but with no mention of the percentage of cases followed for three years, fifteen years or the twelve intervening years respectively; the second report presents over sixteen hundred radical resections with no follow-up results, but with the conclusion that it is the operation of choice.

To the surgical clinics of this country we are indebted for many valuable and carefully prepared reports on this phase of the problem, and thus it seems especially fitting that this association should have chosen for part of its consideration this year a discussion limited to follow-up facts.

The rôle which the writer will play in this discussion will be an humble one as the number of cases presented in this paper is not large, but the fact that the study is based upon his review of each follow-up visit, and that the results presented have been evaluated after careful observation based upon personal interviews with the patients and actual examinations in the follow-up clinic in 95 per cent. of the observations recorded, may justify its presentation.

Because of limited time, the results in but two types of surgical therapy will be presented here, viz., gastroenterostomy and partial gastrectomy for ulcer of the duodenum and stomach. These operations were performed by the members of the surgical staff of the Presbyterian Hospital in New York between the years 1916 and 1929, hence not the statistics of any one operator.

The cases presented include all of those in which the surgeon elected one of the two operations mentioned, regardless of the condition of the patient, operative risk or complications such as previous or active hæmorrhage, com-

plete pyloric obstruction, etc., but do not include the cases of acute perforation.

The operative mortality includes every case which died either as a direct or indirect result of operation and is extremely high, and this is not the result of operations performed by the younger and less experienced men, as it goes without saying that it is the spirit of the clinic that the older men assume the responsibility in the gravest risks. Pulmonary complications have formed a distressing percentage in operative mortality, especially in simple gastroenterostomy in this series.

To any student of the ulcer problem it becomes increasingly evident that in reviewing the results in any form of treatment whatsoever, be it ultra-conservative, such as medical, or any type of surgical procedure, one outstanding feature constantly presents itself in as yet intangible form, viz., the subtle effects of the constitution and temperament of the individual and his reaction to the stress and strain of his environment. This with the well-recognized tendency to recurrence either of symptoms or the disease itself has demanded the form of study here presented, viz., statistical follow-up results shown in their continuity.

Fortunately with the great majority of the patients concentrated within the small radius of a large community it has been possible to carry out the observations on individuals at six-month intervals and thus more carefully observe the fluctuations in the follow-up curve.

In addition, some five years ago the writer began a study of cases of ulcer treated medically on his surgical service by his associates and himself. This was done for our own education and that of our surgical staff, so that first-hand information could be obtained in the observation of these cases under our own conservative management and secondly, so that our background of the behavior of the disease and its response to treatment might be broadened. Admitting these cases to a surgical service for conservative treatment places them directly under our control, and they then can be subjected to the same rigid analysis as to interval results as are the cases treated surgically; and furthermore, when indication for surgery arises in this group, we have a more comprehensive knowledge of the individual and his form of medical treatment. The number of these cases must, of course, be limited at any one time on a surgical service.

Four hundred and thirty-five cases of ulcer, treated on the surgical service, have been reviewed, and of these, gastroenterostomy was performed in 119 cases and partial gastrectomy in seventy-six cases. We have established the presence of marginal ulcer in 6.9 per cent. of the gastroenterostomies and in 3.6 per cent. of the resections performed in our own clinic.

Chart No. 1 presents the death analysis.
Chart No. 2 presents the results in gastroenterostomy.
Chart No. 3 presents the results in partial gastrectomy.
Chart No. 4 presents the results in cases treated conservatively.

POST-OPERATIVE MORTALITY IN GASTRIC AND DUODENAL ULCER

1 GASTRO-ENTEROSTOMY   MORTALITY 15 1 %

 HEMORRHAGE FROM ULCER - 3 DAYS
 HEMORRHAGE FROM STOMA - 1 DAY
 ACUTE DILATATION OF STOMACH - 36 HRS. (STOMA PATENT)
 HEMORRHAGE - 3 DAYS
 PERITONITIS - LEAKAGE AT STOMA - 14 DAYS
 ACUTE ILEUS - UREMIA - 28 HOURS
 HEMORRHAGE FROM STOMA - 3 DAYS
 DEATH ON OPERATING TABLE - (PERFECT SHAPE - NARCOSIS ?)
 PNEUMONIA - 3 DAYS
 PNEUMONIA - 8 DAYS   (WRETCHED SHAPE - AGED 72)
 PNEUMONIA - 3 DAYS
 PNEUMONIA - 3 DAYS
 PNEUMONIA - 5 DAYS
 PNEUMONIA - 13 DAYS
 PNEUMONIA - 9 DAYS
 PULMONARY INFARCT, INFECTED - PLEURISY - 15 DAYS
 PULMONARY EMBOLISM - 9 DAYS
 PULMONARY EMBOLISM - ABSCESS OF LUNG, DRAIN. - 61 DAYS

 MORTALITY DUE TO TECHNICAL ERROR - 5 9 %

2. PARTIAL GASTRECTOMY   MORTALITY 19.6 %

 PERSISTENT VOMITING - UREMIA - 6 DAYS   (POOR RISK)
 ACUTE ILEUS - PERITONEAL ABSCESS - HEMORRHAGE - 4 DAYS
 VOLVULUS - LEAKAGE OF DUODENUM WITH LOCALIZED PERITONITIS - 7 DAYS
 MARGINAL ULCER - PERITONITIS - GANGRENE OF LUNG - 3 WEEKS
 SHOCK - 48 HOURS   (HIGH (LESSER CURVATURE ULCER)
 HEMORRHAGE - LEAKAGE - ILEUS - 7 DAYS
 LEAKAGE DUODENAL STUMP - PERITONITIS - 20 DAYS
 HEMORRHAGE FROM SUTURE LINE - 1 DAY
 LEAKAGE DUODENAL STUMP - PERITONITIS - 8 DAYS
 ACUTE ILEUS - 13 DAYS
 LEAKAGE GASTRIC STUMP - PERITONITIS - 3 DAYS
 ACUTE PANCREATITIS - 3 DAYS
 PNEUMONIA - 4 DAYS
 PNEUMONIA - 4 DAYS
 PULMONARY EMBOLISM - 13 DAYS

 MORTALITY DUE TO TECHNICAL ERROR - 15.8 %

CHART I

A FOLLOW-UP STUDY OF THE RESULTS OF SURGICAL
THERAPY IN GASTRIC AND DUODENAL ULCER

GASTRO-ENTEROSTOMY

119 CASES

SYMPTOM-FREE
IMPROVED BUT NOT SYMPTOM FREE
UNIMPROVED
FAILURE
CURRENT CASE = CASE UNDER OB-
SERVATION THE FOLLOW-UP STUDY
OF WHICH IS INCOMPLETE

CHART II

CHART III

CHART IV

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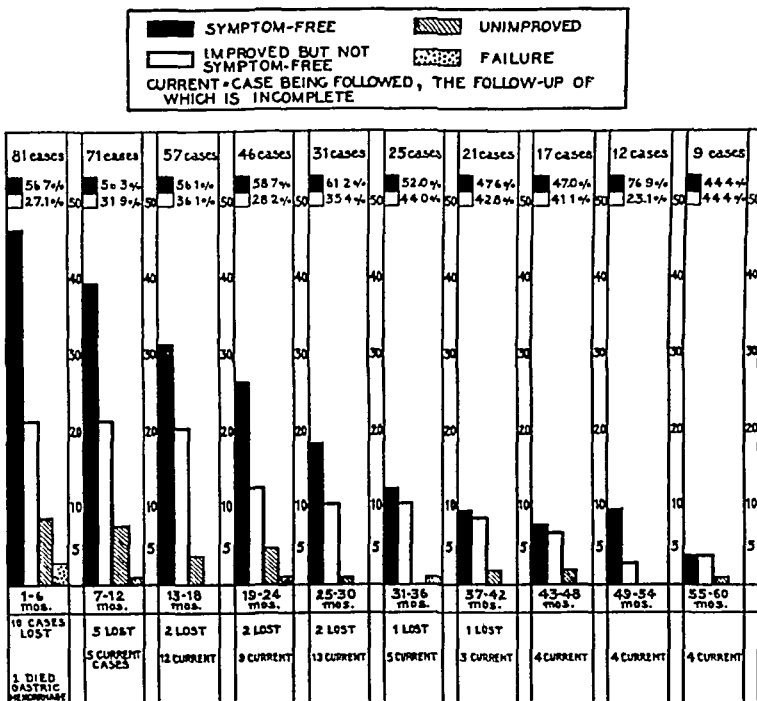
Chart No. 5 presents the method of comparison of the various forms of treatment shown in continuity.

FOLLOW · UP   RESULTS   IN   GASTRIC   AND   DUODENAL   ULCER
WITH   VARIOUS   TYPES   OF   THERAPY

	MONTHS	1 - 6	7 - 12	13 - 18	19 - 24	25 - 30	31 - 36	37 - 42	43 - 48	49 - 54	55 - 60
1. GASTRO - ENTEROSTOMY	NO OF CASES	94	90	83	78	69	65	59	57	49	42
	% SYMPTOM - FREE	72 3	76.6	74.7	69.2	72.4	70.7	83.0	85.9	89 9	83.3
	% IMPROVED	20.3	10 0	18 0	20.5	17.3	21.5	5 7	8 7	8.5	9.5
		92 6	86 6	92.7	89.7	89.7	92 2	88.7	94 6	98 4	92 8
2. PARTIAL GASTRECTOMY	NO OF CASES	57	53	50	48	47	45	42	32	30	24
	% SYMPTOM - FREE	73 7	81 1	72 0	79 1	82 9	84.4	78 5	80 9	87 5	86 6
	% IMPROVED	21.5	15.0	18.0	14.3	10.5	11.1	18.8	7 1	9 3	10 0
		95 2	96 1	90.0	93 4	93.4	95.5	97.3	88.0	98.6	96.6
3. CONSERVATIVE TREATMENT	NO OF CASES	81	71	57	46	31	25	21	17	12	9
	% SYMPTOM - FREE	56 7	56.3	56 1	58.7	61 2	52.0	47.8	47.0	76 9	44.4
	% IMPROVED	27.1	31.9	36.8	28.2	35.4	44.0	42.8	41.1	23.1	44.4
		83 8	88 2	92 9	86 9	96 6	96.0	90 6	88 1	100 0	88 8

CHART V

CONCLUSIONS

1. The high mortality in gastroenterostomy in this series is largely due to pulmonary complications. General anæsthesia has been used as a rule. Undoubtedly local or spinal anæsthesia would have lowered the incidence of pneumonia.

2. The high mortality in partial gastrectomy is probably due primarily to the fact that it has not been performed in simple duodenal or pyloric ulcer, but rather in the advanced, penetrating lesions of the pylorus and lesser curvature.

3. Medical treatment by the surgeon has been of educational value.

4. A follow-up study in continuity presents illuminating facts, the most important of which is the evidence of fluctuation of result due to intangible factors. These require further investigation.

5. Observations of the result of treatment should not be discontinued at any definite period following operation.

6. It must be borne in mind in comparing surgical and medical results that surgery in most clinics to-day in simple ulcer is only instituted at the point where medicine has failed.

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PEPTIC ULCER SURGICAL ASPECTS INCLUDING END-RESULTS

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THIS report represents a personal study of a group of 152 surgically treated peptic ulcers from the Department of Gastroenterology of the Cornell Clinic. The writers believe that this group is unique in that the cases were operated on in many different hospitals (twenty-six) by many different surgeons (forty-six). Many of the cases, after having been advised to have surgery performed, have gone to the referring physicians or to other clinics. Therefore this series seems to offer a very fair cross-section of results obtained from surgery performed in this condition around New York City.

In pursuing this work the first step was to study in some detail each of the case records on file at the clinic, checking the pre- and post-operative diagnoses, the type of operation performed, and listing the cases suitable for follow-up. It has been possible to personally examine eighty-five cases of operated peptic ulcer. Each case was examined and closely questioned concerning the result, and in all cases the patients were given an X-ray examination by the writer in the Clinic Department of Röntgenology. It is felt therefore that since the group was examined by one who had nothing to do with the surgery performed conclusions can be taken as unbiased.

Diagnosis.—The diagnosis of duodenal ulcer was made in ninety-two cases and the ulcer was found in the position indicated by X-ray in eighty-two, or 89 per cent., of the patients. In only four, or 4.3 per cent., was no lesion found and in the remaining cases a gastric ulcer was found in one, a pyloric ulcer was found in three, and a carcinoma of the pylorus in two. With respect to those cases in which no lesion was found it must be kept in mind that this does not entirely rule out ulcer, for there is one case in our follow-up series in which no ulcer was found at the first operation only to have it demonstrated at the second exploration.

The diagnosis of "ulcer or carcinoma" (lesion near the pylorus) was made in sixteen cases and all of these showed a lesion, three being duodenal ulcer, six cancer of the stomach, four gastric ulcer, one showed a cancer developing in a gastric ulcer, and the other two were extragastric lesions, a chronic pancreatitis and a chronic gall-bladder with peri-duodenal adhesions.

Twenty-nine cases were diagnosed as gastric ulcer and this type of lesion was found in seventeen, or 62 per cent., four proved to be carcinoma, one showed both gastric and duodenal ulceration, one was lymphosarcoma, one was a Harris' band, and one was a duodenal ulcer with pre-pyloric adhesions. One was duodenal adhesions and one was a gastric ulcer with a chronically diseased gall-bladder. Thus in this twenty-nine cases only two, or 6.9 per cent., failed to show either ulceration or neoplasm.

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One case was diagnosed duodenal ulcer with diverticulum and these were found. Two cases were diagnosed merely pyloric obstruction and in these were found pyloric ulcers. One case was "cancer, ulcer, or spasm" and a negative stomach was found.

This series shows that it is most difficult to definitely localize the parapyloric lesions, that is, the lesions which are within a short distance one side or the other of the pyloric ring. And it must be said that probably the difficulty is not all on the side of the expert Röntgenologist. The lesion in seven cases was localized at the pylorus; in six of these the operator placed it in the duodenum and in one on the gastric side. In eight cases the lesion was called parapyloric and in four of these a duodenal ulcer was found, in two a gastric ulcer, and in one both a pre- and post-pyloric ulcer, and duodenal adhesions only in one case. Two cases were diagnosed "parapyloric ulcer or carcinoma" and in one of these a pre-pyloric ulcer was found and in the other was a duodenal ulcer. One was said to be "parapyloric ulcer with chronic gall-bladder disease" and a duodenal ulcer alone was found. Two were called "pyloric and pre-pyloric ulcer," there being found in one of them a gastric ulcer and in the other both duodenal and gastric ulcers were present.

The question of the exact location with reference to the pylorus might seem to be more or less a quibbling proposition, but it is, in fact, a very important one because it must very largely influence the surgeon in deciding the question of operation in the upper age groups.

Cancer of the duodenum is very rare and if the lesion can be placed with surety in the duodenum the question of malignancy will not strongly influence us to advise surgery.

Of 3563 cases of malignant tumors of the intestine Brill found only 89, or 2.5 per cent., in the small intestine. (Quoted from Ewing, J., Neoplastic Diseases.) Since these figures include carcinoma of papilla of Vater and of the third portion of the duodenum it will be seen that the malignancies of the usual ulcer site must be very rare.

Gastric ulcer or adhesions of the antrum were suspected in one case which proved to be a duodenal ulcer. Three cases were prophesied to be "ulcer, cancer, or lues" and these proved to be in order a pre-pyloric ulcer, a cancer of the stomach, and a gastric ulcer with tuberculous peritonitis. There was no proven case of gastric lues in this series. "Pyloric ulcer or cancer" was predicted in two cases which proved at operation to be a cancer of the stomach and a duodenal ulcer. Gastric ulcer was found in only one case which was diagnosed as cancer. "Duodenal ulcer and chronic cholecystitis" was proven in one case and a case of so-called duodenal ulcer with diverticulum of the jejunum proved to be an hour-glass stomach due to ulcer. A duodenal ulcer was found in only one case in which duodenal adhesions were diagnosed and in one case in which "adhesions or duodenal ulcer" were predicted, no lesion was found.

To summarize, in this group of 174 cases a definite lesion was found

in 167 cases, or 95.9 per cent. This demonstrates very forcibly the efficiency of modern X-ray diagnosis in competent hands.

The group of 152 peptic ulcers is composed of 117 duodenal ulcers (including pyloric and post-pyloric), three double lesions (gastric and duodenal), and thirty-two gastric ulcers.

Treatment.—The patients treated at the Cornell Clinic come from the middle classes and are of moderate means. Therefore, the time element in treatment is a very important economic factor due to the fact that it is essential that they be put in condition to earn their living at the earliest possible moment. They are not able to afford experimentation in treatment nor are they in most cases able to pamper their digestive tracts. In fact, many of them have great difficulty in using an ambulatory ulcer diet both for financial reasons and because of racial habits of eating.

Unless there is indication for immediate operation, such as obstruction, bleeding, perforation, or penetration, the patients are routinely put on a standard ulcer diet of high-calory bland type with three moderate-size and three small meals daily. In addition, they are given a teaspoonful of a neutralizing powder *t.i.d.* The average case shows an immediate although sometimes temporary response to this treatment. Some of the cases, of course, do not respond at all and are advised to have surgical intervention after what seems to be a fair trial. Many of them are carried along with good relief for many months, or even years, but as is the case with all such groups they have a tendency to drift away into other hands after a few months and it is difficult to gauge results accurately. Those who do not respond are submitted to operation.

In the 117 operated cases of duodenal ulcer the average age at entering the Clinic was 37.8 years the youngest being seventeen and the oldest sixty-two. The average duration of pre-operative medical treatment in this group was 5.1 months. However, because of above-mentioned indications, thirty-nine of the 117 cases were operated upon immediately, making the average duration of treatment of the remaining seventy-five cases 7.8 months.

Of the thirty-five cases of operated gastric ulcer twenty-six were operated upon immediately, thus showing the influence of the fear of malignancy. The remaining nine cases received an average of 8.1 months of observation at the clinic and the average age of all the operated gastric ulcers on entering the clinic was forty-four years.

The average case of gastric ulcer in this series has had symptoms for 5.9 years pre-operative and the duodenal ulcers have had symptoms for an average for the entire group of 6.9 years between the onset of symptoms and the operation. The longest period between onset of symptoms and operation in the duodenal group was twenty-eight years and in the gastric group thirty-four years; and the shortest period in each group was respectively three months and two months. Twelve cases of the entire group had symptoms for over twenty years and thirty-two of them suffered for over ten years without relief.

It is interesting to note that in this series of 152 cases, twenty-four, or 15.8 per cent., had had previous operations for digestive symptoms. These include two cases of cholecystectomy for the same symptoms, one of which had a subsequent negative exploration and one case which had a cholecystectomy and exploratory gastrotomy without relief. There were, in addition, three cases which had single acute perforations, two cases which had had previous gastroenterostomies and one case in which the ulcer of the stomach had been excised, the case several years later requiring a gastroenterostomy for relief of stenosis. All of these were apparently carefully explored and given the indicated treatment according to the evident pathology but the same cannot be said for those cases which previously had appendectomy for the same digestive disturbances. This group comprises fourteen and includes only chronic cases and only those cases whose ulcer symptoms started before the onset of the so-called appendix symptoms. These fourteen are all duodenal ulcers. It is interesting that none of the gastric ulcers had been previously operated on for chronic appendicitis. Thus 11.9 per cent. of the operated duodenal ulcers had had previous laparotomies for chronic appendicitis and many of them showed McBurney scars.

INDICATIONS FOR OPERATION: 1. *Persistent or recurrent pain* has been the indication for operation in fifty-two duodenal ulcers and three gastric ulcers and, in addition, in one double lesion. The pain was unrelieved by medical treatment or recurred in severe form after the usual ambulatory treatment. The test of medical treatment is indeed severe, for the patients are forced to earn their own living and many choose the operation or are offered operation when medical treatment has failed. Success of any form of treatment in this type of patient usually means the ability to put in from eight to twelve hours at hard work.

2. *Pyloric obstruction.*—This is, of course, a prime indication for surgery and no hesitation is felt in advising an operation when the patient shows twenty-four-hour retention of part of the opaque meal after this finding is confirmed by a second examination. Thirty-two cases of duodenal ulcer and ten cases of gastric ulcer were operated on because of this indication.

3. *Penetration.*—A deeply penetrating lesion of the lesser curvature is considered an indication for surgery if it does not improve in two weeks clinically and by X-ray. The same advice is given to a patient whose pain suddenly changes in character and severity and which is not relieved by alkalis or food. These cases are considered candidates for acute perforation and are usually advised to undergo operation unless they can be kept under very close supervision. Ten gastric and three duodenal ulcers have been operated on for this indication. One double lesion also was operated on for this indication.

4. *Acute perforation.*—Five duodenal ulcers have been operated for this reason and likewise two on the gastric side. In addition, one double lesion has been operated on for this reason. Several more of each group have perforated after having been sent to the surgical wards and while awaiting opera-

tion for other indications. Few acute perforations are seen at the clinic because most of them are taken to the hospitals by the ambulances from the street or from work.

5. *Hæmorrhage.*—Only three cases, all duodenal, have been explored because of hæmorrhage and, in fact, only seventeen patients in the entire ulcer series gave a history of tarry stools. One case with a double lesion was operated on because of both bleeding and perforation.

6. *Question of malignancy.*—At this clinic every effort is, of course, made to decide whether or not a lesion is malignant and when the diagnosis between ulcer and cancer is doubtful operation is always advised particularly in patients over forty. Seven parapyloric lesions in which cancer was suspected have been operated on and found to be duodenal ulcers and seven gastric ulcers have been found in the same type of parapyloric lesion.

7. *Marginal ulceration.*—This was diagnosed in two cases and is considered a real indication because of the severe symptoms and the danger of complications, such as perforation and fistula formation.

8. *Unknown indications.*—At other clinics operations were undertaken for reasons unknown to us in thirteen duodenal ulcers after the patients had left the clinic for treatment elsewhere.

TYPE OF OPERATION. 1. *Gastroenterostomy* (posterior) was employed in over half the cases, being used in eighty-three duodenal ulcers and three gastric ulcers. Additional cases have been subjected to this operation in combination with other procedures. One chronic and one perforated duodenal ulcer had a suture of the ulcer combined with gastroenterostomy. Cauterization of the ulcer and gastroenterostomy were combined in three chronic duodenal ulcers and two gastric ulcers. One duodenal ulcer had a pyloric ligation combined with gastroenterostomy and one gastric case with hourglass contraction was given a double gastroenterostomy. Thus ninety-eight cases had gastroenterostomies, either simple or combined with other procedures.

2. *Polya resection* with end to side anastomosis of stomach to jejunum was done in eleven duodenal ulcers and twelve gastric ulcers and also in one double lesion.

3. *Billroth II* resection with posterior gastroenterostomy was done in five chronic duodenal ulcers and nine chronic gastric ulcers and in one each of perforated gastric and double lesion.

4. *Pyloroplasty* (alone) was performed in only two cases, both being, of course, duodenal ulcers.

5. *Billroth I, sleeve resection and cautery excision* combined with *gastroduodenostomy* were each used once in gastric ulcer.

6. *Cautery excision (alone), freeing of adhesions and unhooking of gastroenterostomy* were each done once in duodenal ulcer.

7. *Pyloroplasty plus wedge resection* was used once in a double lesion.

8. *Simple suture* of acute perforation was used in one case of gastric ulcer and three cases of duodenal ulcer.

MORTALITY (*immediate operative*).—Gastroenterostomy in ninety-two duodenal ulcers gave an operative mortality of 2.1 per cent. There was no mortality in six cases of gastric ulcer in which this operation was used.

Polya Resection in eleven duodenal ulcers showed an operative mortality of 36 per cent. and in twelve gastric ulcers a mortality of 17 per cent.

Billroth II in five duodenal ulcers showed no operative mortality while in ten gastric ulcers it showed 20 per cent. mortality.

Because of the smallness of the groups of the other types of operation their mortality will not be considered.

From the standpoint of safety it seems evident that in the chronic duodenal ulcer gastroenterostomy is the safest procedure and the preferability of this operation will be still further emphasized when end-results are considered. The lesson is not so clear in the case of gastric ulcer because of the small number of cases, but it seems that a resection large enough to include the whole lesion with either a Polya anastomosis or posterior gastroenterostomy offer the best chance of survival.

TABLE I

POST-OPERATIVE COMPLICATIONS

	Gastric	Duodenal	Double Lesion
Hernia	4	9	
Pneumonia	4	4	
Evisceration	1	4	1
Cellulitis of wound	3		
Fatal post-operative vomiting	1	1	
Duodenal fistula		1	
Phlebitis	1		
Acute psychosis	1		
Erysipelas	1		
Septicæmia and subdiaphragmatic abscess	1		
Peritonitis			1
Fatal shock	1		
Pulmonary œdema		1	
Lung abscess		1	

The primary operative mortality of the whole group has been sixteen cases, or 10.6 per cent. The duodenal ulcers had a general mortality of 5.9 per cent. and the gastric ulcers a general mortality of 22 per cent. Two of the three double lesions died following operation. A startling feature of this mortality is the large number of cases of evisceration and the high mortality of the condition.

The mortality seems large but it must be remembered that there has been no selection of cases. They have been disposed of as they came to view and many of the cases which died had serious pre-operative complications.

One perforated gastric ulcer, two perforated duodenal ulcers, and one case which had a chronic gastric ulcer and two perforated duodenal ulcers died after operation. Only one of these, a duodenal, was given a resection,

TABLE II

CAUSES OF DEATH

	Duodenal	Gastric	Double Lesion	Secondary Operation
Evisceration	3			1
Evisceration and hæmorrhage			1	
Pulmonary œdema	1			
Pneumonia	1	4		
Peritonitis and pneumonia			1	
Lung abscess	1			
Psychosis	1			
Post-operative vomiting		1		
Shock		1		
Septicæmia		1		
Intestinal obstruction				1

the others being merely sutured. The serious nature of the cases is shown by the following example:

Charles B., aged forty-two, was admitted to the clinic complaining of typical ulcer pain and extreme loss of weight over a period of ten years. Fluoroscopy showed an extensive duodenal lesion and on medical treatment he did well for two years when he suddenly gave evidence of perforation and serious bleeding. He was advised to enter the hospital immediately but did not do so for four days. At operation there were found two perforated duodenal ulcers. The perforations were closed and gastro-enterostomy was done. Several days later the wound broke open and secondary suture was performed but the patient died on the thirteenth post-operative day. Autopsy showed in addition to the other lesions a large gastric ulcer. The cause of death was given as acute dilatation of the stomach, hæmorrhage and evisceration.

Disregarding the acute perforations, of which only eight were seen at the clinic, the duodenal mortality becomes 4.4 per cent. and the gastric becomes 26 per cent.

Three cases of duodenal ulcer are known to have died from one to four years after operation from causes not related to their ulcers. In addition, one duodenal ulcer died from intestinal obstruction eleven months after the first operation:

Charles K., aged forty-eight, was admitted to the clinic in 1922 complaining of ulcer pain, fluoroscopy showing an extensive post-pyloric ulcer with retention. Surgery was advised immediately but gastroenterostomy was not done until two months after admission. Ten months later the patient returned complaining of moderate recurrence of pain and X-ray showed a hyperactive stomach with the meal emptying through both the cap and stoma. One month after this word came that he had developed intestinal obstruction, had been operated on without cause for the obstruction being found and had died sixteen days post-operative.

A total of twenty-two cases of the group (152) are dead, or 14.2 per cent.

Secondary operations.—Two gastric ulcers had secondary operations, both with fatal issue: one for persistent vomiting unrelieved by a jejunostomy, and a second (perforated) for evacuation of a subdiaphragmatic abscess. Four duodenal ulcers had secondary suture of the wound for evisceration as did one double lesion and one gastric ulcer. One duodenal ulcer developed a gastrocolic fistula three years after gastroenterostomy.

Henry D., aged forty, was admitted to the clinic in 1924 complaining of a typical ulcer syndrome. After fluoroscopy, which showed a post-pyloric ulcer, medical treatment was tried for six weeks without relief and gastroenterostomy was performed. The convalescence was stormy. After sixteen months of freedom from symptoms he again began to have pain and X-ray showed a tender stoma.

It is probable that about this time he developed a marginal ulcer although he was fairly well until eighteen months later when he began to have gaseous eructations followed in a short time by a severe diarrhœa and loss of weight. Barium enema showed a gastrocolic fistula and the patient was shortly explored. The fistula was closed and the gastroenterostomy was reëstablished. The patient made a good recovery and was well one year later, barium enema at that time showing no evidence of fistula.

The following case which also had a secondary operation is interesting from several angles:

Anna D., aged thirty-two, was admitted to the clinic in 1927 complaining of a mild ulcer syndrome and also of two fainting attacks followed by tarry stools. Fluoroscopy showed a small lesion near the apex of the duodenal cap.

Because of the history of recurrent severe bleeding, operation was advised. An ulcer (of the second portion of the duodenum) was resected and a gastroenterostomy was performed. She made good recovery but eight months after leaving the hospital she had another severe hæmorrhage and a second operation was performed consisting of a resection of the pylorus converting the gastroenterostomy into a Billroth II resection. One year after the last operation the patient was in satisfactory condition.

It seems likely that in this case there was a second ulcer which was not found at the first operation and which was causing the bleeding or that a second bleeding ulcer formed subsequent to the first operation. This case well illustrates the fact that when a gastroenterostomy stoma has been placed at the mid-portion of the stomach it is possible if necessary to convert this procedure into a Billroth II resection very easily.

Two cases were operated upon three times after admission to the clinic. One of these is as follows:

Thomas McG., aged thirty-four, was admitted to the clinic complaining of periodical attacks of pain over a period of eight years. At fluoroscopy a diagnosis of duodenal ulcer and chronic appendicitis was made and after diet for two months had not relieved him, operation was advised. A healed duodenal ulcer with adhesions and a chronic appendix were found. The adhesions were freed and appendectomy done.

Soon after operation the old symptoms recurred and a second operation, cholecystectomy, excision of the ulcer and gastroenterostomy were done.

As a result of this procedure the patient developed a ventral hernia which made necessary a third operation.

The following case also had three operations and illustrates the severe nature of the disease and the severe complications found even in this small group of cases. It also illustrates the occasional durability of the human frame.

John M., aged twenty-four, was admitted to the clinic in 1924 complaining of ulcer pain which he had had for five years. Four years before he had been operated on for perforated duodenal ulcer. Two years after this he had had a second suture of a perforation, as before, with no gastroenterostomy. At the second operation, however, the ulcer was sutured, an abscess of the pancreas drained, and an appendectomy per-

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formed beside freeing adhesions and repair of a ventral hernia resulting from the first operation.

In spite of this formidable procedure his pain recurred and at the clinic fluoroscopy showed a duodenal ulcer with adhesion, operation being advised.

At operation there was found a third perforation extending this time into the liver. The ulcer and gastric antrum were removed and posterior gastroenterostomy performed (Billroth II).

At the present time, four and one-half years after the last operation, the patient is working twelve hours a day and complains of only slight nausea in the morning. He eats anything but pork, and fluoroscopy shows two-thirds of the stomach remaining and a finely functioning stoma. The patient is satisfied, and should be, after surviving all these troubles.

At the present time many surgeons do not believe in performing gastroenterostomy in perforated ulcers, particularly if the perforation is of more than a few hours' duration, but it seems clear that this case should have had one at the second operation instead of some of the other less indicated manipulations.

END-RESULTS

Eighty-five post-operative cases of peptic ulcer have been personally investigated in this study. All of these have been completely examined at the clinic. Their present condition has been directly compared with their status before operation. The average time of follow-up has been 3.2 years. The time of follow-up may be summarized as follows:

No. of Cases		Time Followed
15	....	1 year or less
16	....	1 – 2 years
6	....	2 – 3 years
15	....	3 – 4 years
7	....	4 – 5 years
15	....	5 – 6 years
11	....	6 – 7 years

An outstanding feature of the eighty-five operative cases has been the failure of the hospitals to follow their cases for more than a few months, and, in many cases, the follow-up, when attempted, has been very sketchy. In most instances it has not included an X-ray examination and many have been followed, if at all, only by letter. To our minds this is not sufficient. Some of these patients who are in good condition from a clinical standpoint show at X-ray examination serious difficulty which affects the prognosis and immediate course of action. Sometimes there seems to be little direct relation between the clinical findings and the functioning of the stomach under the fluoroscope.

Further, the vague character of the post-operative instructions as to treatment given many of them during even the first six months of their convalescence has been very noticeable. Some have been told they can eat anything; some have been given diet slips with careful instructions. Too many have been let go without being properly impressed as to the importance

of care in diet. The whole situation resolves itself into the fact that some-one should assume the responsibility for the patient as much after the operation as before and perhaps more so. This would improve results and would make happier many an uncomfortable post-operative case. It must be said that these cases usually cannot eat everything, as is sometimes so sanguinely promised, but they can usually become practically normal otherwise as opposed to their pre-operative condition of severe pain, vomiting, and loss of weight. The exceptions to this are found in the resected group. The moral to be drawn is that someone should be responsible for these people and they should not be made to suffer from the break in continuity of treatment which usually results when they are passed from clinician to surgeon and back again. All theory to the contrary notwithstanding, an ulcer of the duodenum even after removal remains a potential source of trouble and when the question is asked how long a post-operative patient must remain under observation, the answer should be "permanently."

The evaluation of the results of any procedure is quite difficult. The personal attitude of the examiner, mental attitude of the patient, and the method of the examination all enter into the equation. We have classified as excellent the cases which are free from symptoms, are able to use a liberal diet, and have a well-functioning stomach by X-ray. Those which have slight attacks of pain occasionally and needed a moderately restricted diet or perhaps have a stomach which by X-ray does not seem to function at its highest efficiency are classified as "satisfactory." Those which have their old trouble although in milder form and need a strict diet are classified "fair." In these latter the operation cannot be said to have entirely failed. Those cases which are unimproved or developed serious complications are classed as "unsatisfactory."

Posterior gastroenterostomy in duodenal and pyloric ulcer gave excellent results. Performed in fifty-four followed cases for an average of 3.5 years the results were excellent in thirty-nine, or 72 per cent. Eleven of these cases can be classed as satisfactory (20 per cent.); three had fair results, and two were unsatisfactory. To illustrate an excellent result:

Mary C., aged thirty-three, was admitted to the Cornell Clinic in December, 1925, complaining of epigastric pain relieved by food and vomiting. X-rays showed an extensive duodenal ulcer, duodenal stasis and moderate ptosis. The routine medical treatment gave no relief and operation was advised. Posterior gastroenterostomy was performed. At the last examination, three years post-operative, she was free from pain, had gained twelve pounds, could eat anything, and X-ray showed a well-functioning stoma.

The following illustrated a case which is classified satisfactory:

Armando C., aged forty-three, was admitted to the clinic in March, 1923, complaining of epigastric pain of seven years' duration, the pain being relieved by soda and vomiting. X-ray showed a post pyloric ulcer. He was treated by his own physician and three months later a posterior gastroenterostomy was performed. He was well for five and one-half years, until six months before his last visit to the clinic when he had begun to have slight pain. However, he was twenty-five pounds heavier than at the

time of operation and was well satisfied with the results. X-ray showed an overactive stomach with deep peristaltic waves, the stoma emptying very slowly and the pylorus being only slightly patent. The stoma was placed higher posteriorly than usually and well up on the greater curvature of the stomach.

This case illustrates several points of interest. In the first place this patient was well for five and one-half years before he had a recurrence of symptoms, showing how difficult it is to reach any final decision with regard to any particular case at any particular time. Secondly, it illustrates the importance of checking these cases by X-ray for the placing of the stoma and the overactivity of the stomach could only be determined in that way. Thirdly, it shows one error, according to common usage, in placing the stoma.

The following illustrates a "fair" result:

Hubert M. was admitted to the clinic in 1927. The diagnosis of duodenal ulcer was made and three months' medical treatment failed to relieve him. Operation was finally advised, mainly for a suspected subacute appendix. Since operation (gastroenterostomy and appendectomy) he has had burning pain in the epigastrium relieved by soda. He has vomited and belches a great deal and is sick enough at times to quit work. X-ray shows the meal to be emptying through both the cap and the pylorus. The stomach was hyperactive.

In spite of all these symptoms the patient declared himself to be somewhat improved.

There were two completely unsatisfactory cases in this group of gastroenterostomies. The first developed a gastrocolic fistula, probably on the basis of a marginal ulcer and has been quoted above. The second case follows:

Ruth S., aged twenty-five, was admitted to the clinic in October, 1925, complaining of ulcer pain. Fluoroscopy showed a very defective duodenal cap but no obstruction. She was very obese because of a bilateral salpingo-oophorectomy. After eight months without permanent relief, operation was advised and gastroenterostomy was performed. She was well for two and one-half years but then began to have pain. Examination showed a huge ventral hernia and a markedly contracted stoma which was shown only on the plates. Operation (diagnosis marginal ulcer) was advised but refused. There was a very small stoma with evidence of many adhesions in the same region on the greater curvature of the stomach.

The placing of the stoma as shown by the post-operative X-ray has been usually in the dependent portion of the stomach. Many, however, have been placed near the pylorus and in a few of this type the emptying of the stomach through the stoma has so nearly simulated the action of the normal pylorus that it was hard to distinguish between the two. The actual location of the stoma, within reasonable limits, seems to have little effect on the clinical result and even on the emptying as determined by the opaque meal. The following case is an extreme example of the fact:

Michael K., aged thirty-one, was admitted to the clinic in 1924 and the diagnosis of parapyloric ulcer was made. He has lost twenty pounds and showed twenty-four hour retention, gastroenterostomy being performed. Examination five years after operation proved that he had gained fifteen pounds, was doing heavy work as a carpenter, and was having only a mild attack of pain each summer. He was eating everything. X-ray examination showed the most extreme example of poor placing of the stoma. It was

on the greater curvature of the stomach but very near the cardia. The stomach emptied rapidly through the stoma and the patient was entirely satisfied with the result.

Examination of these patients has left the writer with the impression that the antral location is best, provided there is no likelihood of the future necessity of resecting, in which case an antral location would make resection more difficult.

To summarize: of fifty-three gastroenterostomies, thirty-seven had the stoma at the dependent portion of the pars media, eleven had the stoma on the antrum, two had the stoma high posteriorly, and in one, the case mentioned above, the stoma was placed far to the left and near the cardia. In addition, two cases showed a stoma slightly to the left of the mid-portion.

One of the most interesting cases this study has brought to light is a case of duodenal ulcer wih simple gastroenterostomy. This case came back four and one-half years after operation and had gained thirty-five pounds. He was the picture of health and used an unlimited diet. Two weeks before his return he had begun to suffer slightly with epigastric pain coming on one hour after meals whereas his old pain had been three hours after meals. He appeared to be in fairly satisfactory condition until X-ray examination proved the existence of a large penetrating ulcer on the lesser curvature of the stomach. It seems that the gastric lesion is a recent development.

Polya resection (or a variation of this operation) was performed in seven returned cases of duodenal ulcer. Three of these cases can be classed as excellent, one as satisfactory, two as fair and one as unsatisfactory. X-ray showed all of these cases to have a well-functioning stomach. Two which were "satisfactory" had associated gastro-intestinal trouble which interfered with a perfect result.and one of the "fair" cases still had pain and the need for alkaline powders. The other "fair" result was said to have developed a marginal ulcer which could not be demonstrated at the recent examination and in addition was definitely neurotic.

One patient had his gastroenterostomy unhooked six months after the first operation when a marginal ulcer was suspected but not found. This patient is at present "satisfactory," having very slight distress and a somewhat limited diet. It is questionable whether his ultimate result will be good, many surgeons believing that unhooking gastroenterostomy in duodenal ulcer always leads to a reactivation of the ulcer.

One duodenal ulcer which had a simple resection of the ulcer returned 5.75 years after operation with the history of belching, pain and nausea, although these symptoms were not severe. She was classed as "fair." It is probable that this patient would have had a much more nearly perfect result if gastroenterostomy had been added to the procedure. None of the recently operated ulcers have had resection without gastroenterostomy.

Another case had a pyloroplasty (Horsley) for duodenal ulcer. He gained weight and was symptom-free 6.5 years post-operative but it classified only "satisfactory" because of a hyperactive, hyperperistaltic stomach.

One penetrating duodenal ulcer had the ulcer infolded and gastroenterostomy performed. The treatment was probably satisfactory but the result was obscured by a psychosis, one of the few encountered in this group which was remarkably free from such types of patients.

Another case had cauterization of the ulcer with gastroenterostomy and had no trouble 6.5 years after operation.

The two perforated duodenal ulcers were each examined 3.5 years after operation. Each had had simple suture and X-ray of one showed a normal duodenum and stomach while the other showed a persistent defect. Each was having an occasional mild attack of pain but no obstruction had developed as is so often to be expected in these cases of suture following perforation. They are classed as "satisfactory."

Two duodenal ulcers, already cited, had Billroth II resections, one as the second operation for bleeding and the second as the third operation. The latter is classed as excellent and the first as "satisfactory" because of mild symptoms.

From these cases it seems possible to draw the not very novel conclusion that posterior gastrojejunostomy is the operation of choice in the hands of the average surgeon in duodenal ulcer provided the indications are good. It will cover the whole field except perforation, even including bleeding. The mortality is low and we have shown the results to be as satisfactory as the results of almost any type of therapeutic procedure.

Seventeen gastric ulcers have been examined. Of the various operations performed on these cases the Polya or its variations have been done most frequently (12 times). The remarkable features of the eight cases (of Polya resection) examined is that they were uniformly excellent results—provided the patients recovered from the operative procedure. Only two died, one of tuberculous peritonitis and the other of pneumonia. The cases were followed an average of 2.8 years post-operative.

One case of wedge resection for ulcer of the lesser curvature has been examined. Eighteen months after operation the patient was symptom-free and X-ray showed no defect and no interference with peristalsis. Disregarding a huge incisional hernia the result would be "excellent."

Suture of a perforated gastric ulcer near the pylorus with gastroenterostomy was done once and this case must be classed "unsatisfactory" because of the probable development of a marginal ulcer. This was unproved because of refusal of the patient to submit to a second operation, although he was very miserable.

Only one case with a gastric ulcer high on the lesser curvature which had had a gastroenterostomy alone returned for examination. In this case the placing of the gastroenterostomy below the site of the ulcer high on the lesser curvature was futile and may also illustrate the possibility of malignant degeneration of a gastric ulcer although time alone can settle the latter point.

Edward C., aged forty, was admitted to the clinic in 1927, complaining of indigestion which he had had for nine years. X-ray showed a penetrating lesion of the lesser

curvature of the stomach near the cardia. Surgery was advised. The lesion seemed non-resectable and posterior gastroenterostomy was performed at the dependent portion of the stomach. Two years after operation the patient had gained no weight, had to be very careful of his diet, and X-ray showed finger-printing on the greater curvature which, in the opinion of the X-ray department, meant a malignant process.

Three cases of gastric ulcer in which Billroth II was done were examined and all were excellent. One gastroenterostomy was excellent and another was fair. In one of the hour-glass stomachs in this series a double gastroenterostomy was done and this was free of symptoms 7.5 post-operative. A double lesion for which had been performed a pyloroplasty and wedge resection was found to be free of symptoms six years after operation with an excellent functional result by X-ray.

CONCLUSIONS

1. The efficiency and reliability of X-ray diagnosis of peptic ulcer has been confirmed by this series of cases in which the pre-operative and operative findings have been compared.

2. Economic stress hastens operation in many of the cases appearing at the Cornell Clinic and probably more cases in this social stratum are operated upon than in other groups.

3. Gastroenterostomy has been shown to be a very safe procedure with a mortality of 2.1 per cent. in the hands of many different surgeons. It is likewise excellent from a therapeutic standpoint with 92 per cent. of satisfactory results.

4. The location of the gastrojejunostomy opening does not seem to greatly influence the clinical and mechanical results of operation.

5. Polya resection seems to be the best procedure in gastric ulcer and has given uniformly good results in this small series, but mortality is high.

6. These cases demonstrate the almost uniformly good results of operation for peptic ulcer in the hands of a comparatively large group of surgeons.

7. The accurate determination of end-results requires careful study over long periods. Many cases are followed too short a time and in too little detail.

8. Analysis of individual cases often affords information that is not obtained by a statistical study.

THE IMMEDIATE MORTALITY IN OPERATIONS FOR GASTRIC AND DUODENAL ULCER AND ITS CAUSES

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A statistical paper is of little interest but, if honest, of great value. The more it deals with failures the greater its value.

From January 1, 1920, to January 1, 1930, in my services at the Pennsylvania and Jefferson Hospitals, there have been operated upon 313 cases of duodenal and gastric ulcer. To this number are added twenty-one cases operated upon at the Bryn Mawr Hospital by three of the same group, making a total of 334. These operations do not represent all those done in these institutions, but only those in our own service. They have all been done by six men, Doctors Despard (deceased), Billings, Klopp, Flick, Walkling and myself.

In this series of 334 cases, sixty-seven were cases of acute perforation which will be considered apart from the other larger group. There were eighteen deaths in these sixty-seven cases, a mortality of 26.8 per cent. Peritonitis was the cause of death in nine cases, "chest pathology" in four cases, hæmorrhage in one, embolism in one, empyema in one, local peritonitis and acute degeneration of liver in one and the cause of death is not noted in one case. Ten of these patients were operated on within eighteen hours of the perforation, which is much too high a mortality following operation done within this period. In one of the fatal cases seventy-two hours had elapsed before operation, and in another forty-eight hours. Four deaths occurred in patients operated upon between eighteen and twenty-four hours after perforation. In two cases the duration was not noted. Among the cases which recovered, the interval between perforation and operation was "over twenty-four hours" in one, between nineteen and twenty-four hours in one, between thirteen and eighteen hours in five.

Some years ago Francis T. Stewart and I reported a series of cases in which every patient operated upon within eighteen hours of the perforation recovered, and all operated on, with one exception, after that time died. We are convinced that every hour that passes after the fifth or sixth without operation adds to the mortality. Time is a far more important element in these cases than the type of operation of the character of the after treatment. In these sixty-seven cases simple closure was done in forty-three and closure with gastrojejunostomy in twenty-four. The question of gastrojejunostomy is decided on the extent and duration of the peritoneal contamination and on the condition of the patient.

In these sixty-seven perforations only seven were of gastric ulcers. There were only three deaths in the twenty-four cases where a gastrojejunostomy

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was done, a 12 per cent. mortality, whereas there were fifteen deaths in forty-three cases where only closure was done, a mortality of 35 per cent. These figures are hardly comparable when, as has been said, the anastomosis is only done in the patients who are in the best condition.

Aside from the causes of the mortality already given, there were a variety of complications in the patients who recovered. There were two cases of parotitis; three of phlebitis of left leg; two of pulmonary collapse; one of bronchiectasis or lung abscess (sixteenth day after operation) ; one of late vomiting; one of purpura; one of bronchopneumonia (tenth day) and one of duodenal fistula, this case being complicated at time of perforation by an acute gangrenous appendicitis.

There were twenty-nine deaths in the 267 non-perforative cases, a mortality rate of 10.8 per cent. This mortality we will not attempt to ascribe largely to complicating conditions, multiplicity of lesions or multiple necessary operations, but will look for an explanation in the post-operative developments and in the autopsy records. It is true that in many cases there were present chronic perforations, especially into the pancreas, that a number had both duodenal and gastric ulcers, that a still larger number had gall-bladder conditions which required operation, and that in a large number the appendix was removed, but the mortality does not appear higher in these than in the uncomplicated cases.

The causes of death in this group were: peritonitis, three; pneumonia, eleven; collapse of lung, two; local peritonitis with lung abscess, one; pulmonary embolism, one; subphrenic abscess and empyema, one; subphrenic abscess and lung abscess, one (death on forty-eighth day) ; hæmorrhage, one (gastrectomy) ; intestinal obstruction, three (one on thirteenth day and one on seventeenth day both reöperated upon) ; shock, one (marked dehydration) ; sudden cardiac attack, one (ten days after operation, autopsy revealed no cause) ; post-operative delirium, one (patient tore his wound open on fifth day and tore a large hole in the mesentery requiring a resection of two feet of small intestine). The cause of death was not stated in two cases.

The only comfort to be derived from this list is its variety. The high percentage of lung complications, well over 50 per cent., although regrettable, is somewhat of a comfort as they can hardly be attributed to technical error. It will be seen later in considering the post-operative complications in the cases which recovered, that lung conditions, especially atelectasis, again outnumber all the others combined. Now that collapse is being more generally recognized and successfully treated and is no longer thought to be pneumonia, it may be hoped that it will become a less potent factor in the cause of death.

In going over the histories of the eleven cases where pneumonia was given as the cause of death, we were impressed with the idea that many of them were in reality cases of massive collapse.

In the 267 cases, 224 were duodenal ulcers, forty-one gastric and only two jejunal. Where there was both a duodenal and gastric ulcer, the cases were classed as gastric.

The great rarity of jejunal ulcer in our clinics, where gastrojejunostomy is the common operation for duodenal ulcer, is very striking, for surely all our jejunal ulcers have not gone elsewhere for diagnosis and treatment. We have never been able to understand the high percentage of jejunal ulcers reported from other clinics. The following tables give the operations performed and their mortality.

DUODENAL ULCER

Operation:	Number	Deaths
Gastrojejunostomy	142	15
Gastrojejunostomy Appendectomy	61	4
Gastrojejunostomy Appendectomy cholecystectomy	3	0
Gastrojejunostomy Appendectomy cholecystostomy .	2	0
Gastrojejunostomy cholecystectomy	7	1
Pyloroplasty (Finney)	1	0
Pyloroplasty Appendectomy cholecystostomy	1	0
Pyloroplasty Appendectomy	1	0
Excision—gastrojejunostomy—appendectomy	1	0
Cauterization—gastrojejunostomy	2	0
Pylorectomy .	2	1
Cholecysto-gastrostomy (gall-stones)	1	0
	224	21

GASTRIC ULCER

Operation:	Number	Deaths
Gastrectomy..	15	2
Cauterization—gastrojejunostomy	8	2
Excision .	4	0
Excision gastrojejunostomy	1	1
Pylorectomy	1	1
Cauterization—appendectomy	1	0
Cautery excision	2	0
Gastrojejunostomy	3	1
Gastrojejunostomy Cholecystectomy	2	1
Gastroplasty (hour-glass)	1	0
Double gastrojejunostomy (hour-glass)	2	0
Appendectomy	1	0
	41	8

JEJUNAL ULCER

Operation.	Number	Deaths
Gastrectomy	1	0
Restoration with resection of jejunum	1	0
	2	0

The complications in the cases which survived are much the same as in the fatal cases and in the cases of acute perforation Lung conditions take first place. There are four instances of what was called "chest pathology"— diagnosis based on physical signs. These may have been instances of partial collapse as they all cleared up promptly. There were three cases of definite collapse and one of pleurisy. Suppurating parotitis occurred in four cases;

in two it was double. Nonsuppurating parotitis developed in two instances. This condition has been rather conspicuous in our cases and has given us considerable concern. We try to make all patients chew gum after gastric operations and we think there has been but one case of parotitis where this was done. It has not occurred in the dehydrated cases where it might be expected. Serious wound infection requiring removal of all stitches occurred in two cases. Melena is noted in two cases only, but may have happened in others and not have been noted. There were but two cases of phlebitis. There was one case of acute dilatation of stomach and one of post-operative psychosis (paranoid). There was excessive vomiting in two patients and late vomiting in five. This late vomiting we have not been able to explain. It has always been relieved by a duodenal tube or lavage and by temporarily reducing the oral intake.

We have included in this series one case which at operation was thought to be a carcinoma of pylorus, and inoperable because of extensive glandular involvement, but three years have passed since the gastrojejunostomy was done and the patient is free of symptoms.

We know that two of the patients in this series later developed carcinoma. Such errors in diagnosis will probably always occur, but they are not as frequent as formerly.

Only one anterior gastrojejunostomy was done in these cases and that because of non-rotation of the colon.

Nitrous-oxide and ether were the most common anæsthetics, but in some of the perforations and in the dehydrated cases, infiltration alone or combined with gas was used. In considering the mortality and the post-operative complications in this series of cases, it is apparent that some form of lung pathology is most conspicuous. In the clean cases, wound infections and peritonitis have not been high and there was but one fatal hæmorrhage—a case of gastrectomy (Gibbon).

RESULTS OF OPERATIONS FOR CHRONIC GASTRIC AND DUODENAL ULCERATION

A STATISTICAL STUDY OF A THIRTY-YEAR PERIOD

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To BEGIN with, let us frankly admit that one of the main reasons which prompted us to undertake this study was the fact that we approach an operation for ulcer, either gastric or duodenal, with less confidence in our ability to accomplish a cure through surgical measures, than in the case of the other common non-cancerous surgical lesions found in the abdomen. That we are not alone in this perhaps surprising position is attested by various readily ascertainable facts. If we inquire among professional friends as to their experience with the surgical treatment of gastric and duodenal ulcer, we are apt to find a good deal of dissatisfaction with end-results. Surely the published reports in current literature, even those from the best clinics, are not wholly satisfactory.

As showing the extremes to which this dissatisfaction has gone in certain quarters, let us quote from a personal letter recently received from Sir Cuthbert Wallace, surgeon to St. Thomas's Hospital, London. He writes, "I have never been very well satisfied with the operation of gastrojejunostomy for either duodenal or gastric ulcer, for I believe that there is only one thing that gastrojejunostomy can cure, and that is pyloric obstruction." He adds, "As most gastroenterostomies have to be kept on an alkaline diet, and as the same alkaline diet will keep the patient comfortable without operation, the surgeon had best stand aside."

Compare this attitude with that as shown by the published statistics from those clinics which report the highest percentages of cures, and one cannot fail to be impressed by the disparity between the two. What is the explanation of such a marked disagreement?

The great majority of surgeons will, we think, be inclined to believe that Wallace's view is entirely too pessimistic. On the other hand, such figures as those quoted by Balfour, Crile, Moynihan or Coffey are exceptional. Somewhere between these extremes must lie the answer to the above question, so far as the average surgeon is concerned.

In a previous paper dealing exclusively with duodenal ulcer, we pointed out several variable factors which may exercise considerable influence, favorable or unfavorable, upon both the immediate and late results in statistical studies of a similar nature. Let us enumerate some of the more important of these.

First comes the social status of patients operated upon. Obviously, private patients will, in general, be much better equipped, financially and intellectually,

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to take better pre- and post-operative care of themselves than ward patients. Private patients may be expected to be better operative risks, and in most cases their surgeons will have already passed their probation period. Secondly, a preponderance of certain races, negroes for instance, possibly owing to their well-known lack of resistance to abdominal affections, would probably exert an unfavorable influence upon one's statistics. Thirdly, one series may contain only the private cases of one or two expert surgeons, while another may include the work of a group of surgeons, skilled and less skilled, such as members of the resident hospital staff. Fourthly, the period covered by statistical studies may be a very selected one, or of comparatively recent date. It may be taken for granted, we believe, that surgery for gastric and duodenal ulceration has greatly improved between 1915 and 1930, as compared with the corresponding period between 1900 and 1915, and a lower immediate operative mortality may be expected. Moreover, a series whose end-results are drawn from patients operated upon during the past fifteen years must necessarily show better figures than a series made up of patients who may have had twice as long to develop recurrences or complications. Fifthly, the end-results in one series may have been carefully investigated, and controlled in many instances by personal examination, while in another they may be based on quite meager data.

In the hope of finding a possible explanation of this unsatisfactory state of affairs, we have made a comprehensive review of the results obtained in the Johns Hopkins and in the Union Memorial Hospitals over the period between 1900 and 1930. The cases include both private and ward patients and in one, Johns Hopkins, the ward patients were both white and colored. The operations included in this series represent the work of about thirty surgeons of varying experience.

The study of end-results was made in 1927, of all patients operated upon between 1900 and 1925, so that the shortest interval between operation and report is two years. The patients operated upon between 1925 and 1930 are used only in the estimation of operative mortality. Seventy-seven per cent. of the patients operated upon between 1900 and 1925 replied to our questionnaire and of many of these we were able to get further information from their family physician, or by personal examination. For the latter we are largely indebted to Dr. Walter Hughson, of the Hopkins staff.

The choice of operation depended upon the findings after the abdomen had been opened. It is our invariable practice never to begin an operation with a preconceived idea as to just what we will do, irrespective of the findings. The effort is made at all times to make use of that particular operative procedure which seems best adapted to bring about the desired result in the particular case under operation. In general, however, pyloroplasty, preferably with excision of the ulcer, is the operation of choice when practicable, and gastroenterostomy is reserved for those cases with an obstructed pylorus—since in the presence of a patent pylorus, its results in our hands have proved rather uncertain. One great advantage that pyloro-

plasty has over gastroenterostomy, or the simple ulcer-excision operations, lies in the division of the pyloric sphincter, which is thus, for the time being, put out of action. This effectually does away with reflex spastic pylorospasm so productive of pain and retention phenomena.

In the previous communication, to which we have already referred, we used the classification "died within six months after operation," rather than the more customary "died in hospital"—an extension of the operative period which appreciably increased the apparent rate of operative mortality. We did this because our preliminary survey showed that an unexpected number of deaths occurred during this period, and that the majority of these deaths were traceable either directly or indirectly to the operation. However, since this tabulation caused some confusion in the minds of many who had shown interest in the paper, and gave rise to erroneous impressions, we have here followed the method usually employed, designating as "operative mortality" only those deaths which occurred in the hospital. We still believe, however, that it would be more accurate to take account of this "delayed operative mortality," as differentiated from the immediate or hospital operative mortality.

There were 737 patients operated upon in the two hospitals between 1900 and 1930, of whom 110, or 14.9 per cent. had perforated prior to operation. The operative mortality in the presence of perforation was markedly increased, being 23.6 per cent. as contrasted with 8.6 per cent. for the non-perforated group.

Perforated Ulcers.—Of the 110 perforated ulcers, fifty-six were gastric, fifty-three duodenal and one was a post-operative marginal ulcer. The operative mortality in the gastric ulcer group was 26.8 per cent., and in the duodenal group, 18.9 per cent. Of the thirty-four traced survivors, thirty-one, or 91.1 per cent., had been relieved of their previous ulcer symptoms. There seems to be a slightly greater tendency for gastric and pyloric ulcers to perforate (17.3 per cent.) than for duodenal ulcers (13.5 per cent.). When the miscellaneous procedures only were used (forty-seven cases), the mortality was 29.8 per cent. With gastroenterostomy added, in twenty-eight cases, the mortality was 20 per cent. Excision or suture, with pyloroplasty, resulted also in 20 per cent. mortality, while in the nine cases in which partial gastrectomy was done, the mortality was 11.1 per cent.

The mortality rate in this series of 110 cases is high (28.8 per cent.), influenced largely by the fact that in the earlier years perforated ulcers were not brought to the surgeon until very late.

Chronic Ulcers.—There were 627 chronic ulcers operated upon. Of these, 268 were gastric, 339 were duodenal and twenty were post-operative marginal ulcers. The mortality for the whole group was 8.6 per cent., and 83.9 per cent. of the 330 traced cases were improved by the operation. The operative mortality in 268 cases of gastric ulcer was 9.7 per cent., and 80.8 per cent. were benefited by the operation. The operative mortality for 339 cases of duodenal ulcer was 7.1 per cent., while 86.4 per cent. were benefited.

TABLE I

Operations for Gastric, Duodenal and Marginal Ulcer,
The Johns Hopkins Hospital and the Union Memorial Hospital,
1900—1930.

		Number	Died in hospital	1925–1930 Cases not traced	1900–1925 Cases no reply	New total traced	Living well	Living improved	Living un-improved	Died	Improved	Unim-proved	Previous symptoms benefited by operation	Previous symptoms not benefited by operation
Perforated	Gastric*	56	15 / 26.8%	13	9	19	10 / 52.6%	5 / 26.3%	1 / 5.2%	3 / 15.8%	1	2	16 / 84.2%	3 / 15.8%
	Duodenal	53	10 / 18.9%	21	7	15	10 / 66.6%	4 / 26.6%	0	1 / 6.6%	1	0	15 / 100%	0
	Marginal	1	1											
	Totals	110	26 / 23.6%	34	16	34	20 / 58.8%	9 / 26.5%	1 / 2.9%	4 / 11.7%	2	2	31 / 91%	3 / 8.9%
Chronic	Gastric	268	26 / 9.7%	47	49	146	82 / 56.2%	24 / 16.4%	9 / 6.2%	31 / 21.2%	12	19	118 / 80.8%	28 / 19.2%
	Duodenal	339	24 / 7.1%	92	39	184	115 / 62.5%	36 / 19.6%	18 / 9.8%	15 / 8.2%	8	7	159 / 86.4%	25 / 13.6%
	Marginal	20	4 / 20.0%	16	0	0								
	Totals	627	54 / 8.6%	155	88	330	197 / 59.7%	60 / 18.2%	27 / 8.2%	46 / 13.9%	20	26	277 / 83.9%	53 / 16.1%
All Ulcers	Totals	737	80 / 10.9%	189 / 25.6%	104 / 14.1%	364	217 / 59.6%	69 / 18.9%	28 / 7.7%	50 / 13.7%	22	28	308 / 84.6%	56 / 15.4%

* Pyloric ulcers, even those extending into the duodenum, are here classed as "gastric ulcers."

TABLE II

Results of the Different Operations for Duodenal Ulcers—Chronic

	Number	Died in hospital	1925-1930 Cases not traced	1900-1925 Cases no reply	New total traced	Living well	Living improved	Living un-improved	Dead Im-proved	Dead Unim-proved	Symptoms benefited by operation	Symptoms not benefited by operation
Miscellaneous operations	9	2 22.2%	2	1	4	1	0	3	0		1	3
Gastroenterostomy	170	18 10.6%	72	13	67	42 62.7%	13 19.4%	4 6%	5 8 11.9% 3		60 89.6%	7 10.4%
Pyloroplasty	149	4 2.7%	17	22	106	67 63.2%	22 20.8%	10 9.4%	3 7 6.6% 4		92 86.8%	14 13.2%
Partial gastrectomy	11	0 0%	1	3	7	5	1	1	0		6	1
Totals	339	24 7.1%	92 27.1%	39 11.5%	184	115 62.5%	36 19.6%	18 9.8%	15 8.2%		159 86.4%	25 15.6%

There were four deaths after twenty operations for post-operative gastro-jejunal ulcer.

In the 268 cases of chronic gastric ulcer operated on, there were seventeen in whom such miscellaneous operations as simple excision, atypical resections, *etc.* were performed. Of these patients five died, a mortality rate of 29 per cent. These, according to their histories, were unusual cases; the patients were often very ill, and for some reason or other it was thought either impossible or inadvisable to do one of the more typical operations. In ninety cases, gastroenterostomy was done, with three deaths, or 3.3 per cent. In 102 cases pyloroplasty was done, with nine deaths, or 8.8 per cent. Partial gastrectomy, more or less extensive, was done in fifty-nine cases, with nine deaths, or 15.3 per cent.

In 339 cases of chronic duodenal ulcer, there were nine miscellaneous atypical operations performed, with two deaths, or 22.2 per cent. Gastro-enterostomy was done in 170 cases, with eighteen deaths, or 10.6 per cent.; pyloroplasty in 149 cases, with four deaths, or 2.7 per cent. There were no deaths following partial gastrectomy for this condition.

Taking the operations as such, without regard to the lesion which prompted its performance, we find that gastroenterostomy was performed on 260 patients, with 8.1 per cent. mortality. Pyloroplasty was done on 251 patients, with 5.2 per cent. mortality, while the mortality in seventy gastrectomies was 12.9 per cent. The subsequent results after gastroenterostomy or pyloro-plasty are remarkably parallel. After either operation, exactly 61.1 per cent. of the patients were living and well, while a total of 85.8 per cent. were bene-fited by pyloroplasty and 84.1 per cent. by gastroenterostomy. An apparent difference is found in the figures for later deaths. There were 17.7 per cent. of these in the gastroenterostomy group and 9.9 per cent. in the pyloroplasty group.

When these operations are studied in their application to gastric or duo-denal ulcers, more striking differences appear. Gastroenterostomy benefited 89.6 per cent. of the patients operated on for duodenal ulcer, and pyloroplasty 86.8 per cent. But, when used for gastric ulcer, gastroenterostomy improved only 76.1 per cent., while pyloroplasty improved 83.9 per cent. In this con-nection, we note that partial gastrectomy for gastric ulcer, although having 15.3 per cent. mortality, benefited 88.2 per cent. of its survivors.

The accompanying tables speak for themselves. Anyone sufficiently inter-ested will note some interesting facts brought out by the figures. We might point out various features which we believe have a bearing on the operative mortality. As has been stated above, the mortality for the whole group of chronic ulcers is 8.6 per cent. This includes seventy resections with 12.9 per cent. mortality. Eliminating these, and the various miscellaneous operations, which we have seen are accompanied by a high mortality, we have left 260 gastroenterostomies with an 8.1 per cent. mortality and 251 pyloroplasties with a 5.2 per cent. mortality. In the twenty-one deaths making the gastro-enterostomy mortality are thirteen anastomosis obstructions. If these be

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TABLE III

Results of the Different Operations for Pyloric and Gastric Ulcers—Chronic

	Number	Died in hospital	1925-1930 Cases not traced	1900-1925 Cases no reply	New total traced	Living well	Living improved	Living un-improved	Dead Im-proved	Unim-proved	Symptoms benefited by operation	Symptoms not benefited by operation
Miscellaneous excisions and wedge resections	17	5 29.4%	1	1	10	3	2	2	3 (1)	2	6	4
Gastroenterostomy	90	3 3.3%	28	13	46	27 58.7%	4 8.7%	3 6.5%	12 26.1% (4)	8	35 76.1%	11 23.9%
Pyloroplasty	102	9 8.8%	7	30	56	32 57.1%	11 19.6%	4 7.2%	9 16.1% (4)	5	47 83.9%	9 16.1%
Partial gastrectomy	59	9 15.3%	11	5	34	20 58.8%	7 20.6%	0	7 20.6% (3)	4	30 88.2%	4 11.8%
Totals	268	26 9.7%	47 17.5%	49 18.3%	146	82 56.2%	24 16.4%	9 6.2%	31 21.2% (12)	19	118 80.8%	28 19.2%

OPERATION RESULTS DUODENAL ULCER

TABLE IV

Deaths After Operation for Duodenal Ulcer—Chronic

	Died in hospital	Died during first six months after operation	Late deaths after six months	Died of unrelated causes. Improved by operation	Died of related causes—cancer, another operation (Following operation for marginal ulcer—1)	Cause of death unknown
Gastro-enterostomy	Haemorrhage 14, Obstruction 1, Embolus 1, Cardiac 1, Shock 1 — 18	Obstruction 1	—	Sarcoma 1, Carc. sigmoid 1, Angina 1, Suicide 1	2	2
Pyloroplasty	—	—	7	—	4	—
Resection	Streptococcus peritonitis 1, Empyema 1, Cardiac 1, Pulmonary 1	Empyema 1, Nephritis 1, Not known — — 3	4	Cardiac 4	2	2
Miscellaneous procedures	Pneumonia 2	None	None	None	1	1

eliminated for the sake of comparison, the mortality from gastroenterostomy would have been 2.9 per cent. This is interesting in comparison with the 5.2 per cent. for pyloroplasty—in the majority of which death seems to have been due to some form of pulmonary complication. At any rate, these last figures give us a hypothetical base line which we may reckon as an expected death rate following operations on the stomach and duodenum.

It will be noted that the fourteen deaths from obstruction followed gastroenterostomy for duodenal ulcer. In one the obstruction occurred in the sigmoid flexure, but in the remainder it was related to the actual anastomosis. The onset of the symptoms of obstruction was known in seven of these and the average period before onset was nine days. All these patients were re-operated upon after an average period of five days, following the onset of the obstruction. Among the more frequent conditions found as apparent causes of obstruction were dense inflammatory reaction and œdema about the anastomosis itself. In other instances, there was noted constriction of the anastomosis by the transverse mesocolon, and gastric dilatation.

That the operative mortality for ulcer has been decreased during recent years is evident from the following figures. In the Johns Hopkins Hospital, between 1925 and 1930, there were 112 chronic ulcers operated upon. Thirty-seven were gastric, seventy were duodenal and five were post-operative marginal ulcers. The mortality for this group was 3.7 per cent. Gastroenterostomy, with or without excision of the ulcer, was performed much more frequently, being employed in eighty-four of the cases. The mortality from operation was as follows:

Gastroenterostomy	84 cases—mortality	2.4 per cent.
Pyloroplasty	12 cases—mortality	0 per cent.
Partial gastrectomy	7 cases—mortality	14.3 per cent.
Miscellaneous operations	4 cases—mortality	0 per cent.
Operations for marginal ulcer	5 cases—mortality	20.0 per cent.
	112 cases—mortality	3.7 per cent.

Sixty gastro-enterostomies for duodenal ulcer were performed, with one death.

The distribution of the later deaths is instructive. Following an operation for gastric ulcer, 21.2 per cent. subsequently died, while only 8.2 per cent. had died following their operation for duodenal ulcer. If studied more specifically, the following figures are arrived at:

Later deaths following pyloroplasty	for duodenal ulcer— 6.6 per cent.
Later deaths following gastroenterostomy	for duodenal ulcer—11.9 per cent.
Later deaths following pyloroplasty	for gastric ulcer —16.1 per cent.
Later deaths following partial gastrectomy	for gastric ulcer —20.6 per cent.
Later deaths following gastroenterostomy	for gastric ulcer —26.1 per cent.

Six of eleven later deaths (after six months), following operation for duodenal ulcer, are known to have been unrelated to the previous ulcer or

operation. Two of these patients died following a later operation and in three the cause of death was unknown.

Twelve of thirty later deaths, following operation for gastric ulcer, are known to have been unrelated to their previous ulcer or operation. Ten died of a related cause and in eight it was unknown.

In other words, 54 per cent. of the later deaths following operation for duodenal ulcer, as compared with only forty per cent. in the gastric ulcer group, were unrelated to the ulcer. The difference, allowing for the deaths from unknown causes, seems to be attributable to failure of the operation to cure gastric ulcer, to prevent reulceration, or carcinoma. This opinion is supported by the following facts. In pyloroplasty for gastric ulcer, the ulcer is often removed. In a partial gastrectomy, a larger ulcer is removed, but in this larger ulcer an undiscovered carcinoma may already exist. On the other hand, gastroenterostomy, unless the ulcer is removed at the same time, allows a potential source of later danger to remain relatively unmolested.

Four deaths from carcinoma occurred out of the thirty after operation for gastric ulcer. If, for the sake of comparison, these four be considered as carcinoma at the time of operation and dropped from the series, we still find gastric ulcer less amenable to surgical treatment than is duodenal ulcer. There is still some factor other than the potentiality toward carcinoma that predisposes to poorer results. It happens in this series that tuberculosis was related to gastric to a far greater extent than to duodenal ulcer. Including perforated ulcers, there were seven such cases. Five of the seven patients died within a year and two died after several years. May it not be that tuberculosis is frequently one cause of the less satisfactory results following operation for gastric ulcer?

SUMMARY

Seven hundred and thirty-seven cases of ulcer of the stomach and duodenum were operated on in the Johns Hopkins Hospital and Union Memorial Hospital between 1900 and 1930. One hundred and ten were operated upon after perforation, with an operative mortality of 23.6 per cent. The mortality in all operations for chronic ulcer was 8.6 per cent.

Of the chronic ulcers, 268 were gastric and 339 duodenal. There were twenty operations for post-operative marginal ulcer in the chronic group.

The operations included such miscellaneous procedures as excisions, with knife or cautery, wedge and sleeve resections, either with or without a gastroenterostomy, simple gastroenterostomy, pyloroplasty, with or without excision, and partial gastrectomy. The miscellaneous procedures were applied to those cases in which pyloroplasty or gastroenterostomy were for some reason contraindicated. *Pyloroplasty was the operation of choice for ulcers of the duodenum, pylorus or antrum,* when the ulcer could be included in the pyloroplastic incision and when the duodenum could be satisfactorily mobilized. Partial gastrectomy was occasionally used for duodenal ulcer and more commonly for ulcers of the body of the stomach, when conditions warranted

TABLE V

Deaths After Operation for Gastric Ulcer—Chronic

	Died in hospital	Died during first six months after operation	Late deaths after six months	Died of unrelated causes. Improved by operation	Died of related causes—cancer, haemorrhage, or after another late operation	Cause of death unknown
Gastro-enterostomy	Pulmonary 2 Unknown 1 — 3	Not known 1	11	Cardio-renal 3 Cerebral haemorrhage 1 — 4	Gastric spasm 1 Haemorrhage 1 Peritonitis 1 Carcinoma 2 — 5	2
Pyloroplasty	Suture necrosis 1 Pulmonary 7 Haemorrhage 1 — 9		9	Cardio-renal 3	Pulmonary Tb. 2 2	3
Resection	Operative error 1 Suture necrosis 1 Pulmonary 2 Obstruction 3 Not known 2 — 9		7	Accidents 2 Cardio-renal 1 — 3	Carcinoma 2 2	2
Miscellaneous procedures	Pulmonary 3 Haemorrhage 2 — 5		3	Accident 1	Following abdominal operation—1 1	1

the more radical procedure. Gastroenterostomy was used for ulcers of the lesser curvature and fundus when partial gastrectomy was not practicable; for ulcers of the pylorus and duodenum when difficult mobilization or the presence of excessive scar tissue precluded pyloroplasty.

The operative mortality for this series approximated that of most hospital series covering similar periods, and performed under similar circumstances. The figures by operations are as follows: miscellaneous operations of expediency, 26.9 per cent.; gastroenterostomy, 8.1 per cent.; pyloroplasty, 5.2 per cent. and partial gastrectomy, 12.9 per cent. The operative mortality in eighty-four cases of gastroenterostomy in the Johns Hopkins Hospital between 1925 and 1930 was 2.4 per cent. The operative mortality following pyloroplasty for duodenal ulcer was 2.7 per cent. These operations were done by men of varying experience, from assistants in training, to older experienced surgeons.

The end-results of these operations also correspond closely to those of most similar series—84.6 per cent. benefited by the operation. Duodenal ulcer yielded better results than gastric, even after allowance is made for those gastric ulcers known to have died later of carcinoma.

DISCUSSION OF PAPERS ON MORTALITY AND LATE RESULTS OF OPERATIONS FOR GASTRIC AND DUODENAL ULCERS, pp. 545–631.

DR. JOHN DOUGLAS, of New York, remarked that this symposium must be of great value in clarifying the question of both mortality and end-results of the surgical treatment of gastric and duodenal ulcer. Surgeons in New York are particularly grateful for it because from a certain group there has come the strongest advocacy of the radical treatment for these conditions, equaled only by that from several European continental clinics. This advocacy has been strengthened and fostered by the publication and the emphasis of the poor results of the non-radical procedures, and it seemed to him that the assembling of all of these results can do more than anything else to make the real subject clear. The emphasis on the poor results of non-radical operations has gone so far, at least in New York, that it has discouraged the internists and gastroenterologists from advocating any surgery in most of these cases.

He wished to present a series of tables based on 375 gastric and duodenal ulcers that had been operated on by the group of surgeons in St. Luke's Hospital in New York during the seven years previous to the year 1925, showing the operative mortality and also end-results.

Of the 225 cases of duodenal ulcer, a posterior gastroenterostomy alone was done on 135 with four deaths, giving 2.9 per cent, mortality. In the five-year follow-up of this group of cases there were sixty-eight. Of these, eight showed symptoms, with 88 per cent, of result A. Where there had been an excision or infolding, there were seventeen cases, one showing symptoms; but that group was too small to indicate anything. The same is true of exclusion of the pylorus with gastroenterostomy.

Partial gastrectomy for duodenal ulcer was done in only two cases. Pyloroplasty, twenty-two cases with only 60 per cent, of result A. That is, the five-year follow-up of the cases on which pyloroplasty was done was not so satisfactory as those on which a gastroenterostomy was performed. Nor was it so good as the results of pyloroplasty reported from other hospitals.

In the twenty-four perforated cases, where there was repair of the perforation alone, there were four deaths and, of the ten followed, 75 per cent. showed satisfactory results. This series is too small to afford any conclusion.

Where a gastroenterostomy has been done in ten of the cases, in addition to closure of the perforation, 83 per cent. showed satisfactory results. In only one case was a pyloroplasty done after perforation.

Of the non-perforated duodenal ulcers, in all the various operative procedures, there were eleven deaths in 190 cases, or 5.7 per cent. In 135 cases in which gastroenterostomy alone was done, four deaths, or 2.9 per cent. In the perforated cases we had seven deaths in thirty-five cases, or 20 per cent. (See Table I.)

TABLE I

Duodenal ulcers	No. of cases	Deaths Non-perforated —Perforated	5-year F-up.	Symptoms	Per cent "A" results
Post. gastroenterostomy..........	135	4(4–0)	68	8	88
Post. with excision cautery or infolding......................	17	3(3–0)	4	1	75
Post. with pyloric occlusion.......	3	0	1	1	—
Excision cautery or infolding......	11	0	9	2	78
Pyloroplasty...................	22	3(3–0)	10	4	60
Partial gastrectomy..............	2	1(1–0)	1	0	100
Repair of perforation.............	24	4(0–4)	8	2	75
Repair of perforation with gastroenterostomy..................	10	3(0–3)	6	1	83
Repair of perforation with pyloroplasty......................	1	0	1	0	100
Total.....................	225	18(11–7)	108	19	

As far as the results were concerned, of 108 cases followed up, 82.4 per cent. showed an A result. Results B are the ones in which there were occasional symptoms, and of those there were three in 108 cases. Result C are those cases in whom symptoms appeared with indiscretion in diet. Of these there were five in 108 cases, and eleven of 108 cases were grouped as result D, or bad results. (See Table II.)

TABLE II

Duodenal ulcers

Deaths	(non-perforated cases)	11 in 190 cases	5.7%
Deaths	(non-perforated cases after gastroenterostomy)	4 in 135 cases	2.9%
Deaths	(perforated cases)	7 in 35 cases	20.0%
Cures	(result "A")	89 in 108 cases	82.4%
Symptoms	(result "B" and "C")		
	(1) occasional symptoms	3 in 108 cases	3.0%
	(2) symptoms with indiscretion in diet	5 in 108 cases	4.3%
Symptoms	(result "D")	11 in 108 cases	10.1%

In the gastric series both the mortality is higher and the end-results are not so good. Gastroenterostomy alone was done in only sixty-two of these cases with four deaths or 6.4 per cent., with an A result in 78 per cent. of cases.

With excision, cautery or infolding of the ulcer, in addition to gastroenterostomy, there were twenty-four cases, and in that group only 60 per cent. showed satisfactory results. The other groups are too small to be of very great value. Partial gastrectomy was done in twenty-five cases, and in these, twelve were followed and three gave symptoms, or 75 per cent. good results. There were two deaths—a mortality of 8 per cent.

Of mid-gastric resection there were seven cases. In the three followed we had satisfactory results.

There were only four cases of closure of perforation with gastroenterostomy, with two deaths. Closure of perforation without gastroenterostomy but with cautery or

excision of the ulcer showed eleven cases with no deaths. We were only able to follow six such cases and in those the results were satisfactory. (See Table III.)

TABLE III

Gastric ulcers	No. of cases	Deaths Non-perforated —Perforated	5-Year F–up.	Symptoms	Per cent "A" results
Gastroenterostomy	62	4(4–0)	27	6	78
Gastroenterostomy with excision cautery or infolding	24	7(7–0)	10	4	60
Gastroenterostomy with pyloric occlusion	2	0	1	0	100
Gastroenterostomy with pyloroplasty	1	0	1	0	100
Excision or cautery of ulcer	10	1(1–0)	5	0	100
Jejunostomy	1	0	1	0	100
Partial gastrectomy	25	2(2–0)	12	3	75
Transgastric resection	4	0	0	0	—
Mid-gastric resection	7	3(3–0)	3	0	100
Closure of perforation with gastroenterostomy	4	2(0–2)	1	0	100
Closure of perforation with or without excision or cautery	11	0	6	0	100
Total	151	19(17–2)	67	13	

In the non-perforated ulcers where extensive resection was done, there was 12.5 per cent. mortality. In the non-perforated cases where gastroenterostomy was done, 6 per cent. mortality. The result in these cases was fifty-four in sixty-seven cases, or 81 per cent. result A. Result B, 4.5 per cent. Result C, with indiscretion in diet, 9 per cent. Result D, 6 per cent. (See Table IV.) While the results leave much to be desired,

TABLE IV

Gastric ulcers

Deaths	(non-perforated)	17 in 136 cases	12.5%
Deaths	(non-perforated cases after gastroenterostomy)	4 in 62 cases	6.4%
Deaths	(perforated cases)	2 in 15 cases	13.3%
Cures	(result "A")	54 in 67 cases	81.0%
Symptoms	(result "B" and "C")		
	(1) occasional symptoms	3 in 67 cases	4.5%
	(2) symptoms with indiscretion in diet	6 in 67 cases	9.0%
Symptoms	(result "D")	4 in 67 cases	6.0%

it must be remembered that the majority of the patients were ward cases who could with difficulty be controlled after leaving the hospital. If their diet and methods of life, eradication of focal infection, care of the teeth, etc., could have been looked after I am sure the results would have been still better, as I believe such after-care is essential in obtaining the best results after any form of operation for gastric or duodenal ulcer.

A word about the marginal ulcers. Of the total number of cases diagnosed from 1916 to 1929 there were twenty-two. Those confirmed by some method, X-ray, operation or autopsy, twelve. Primary operation done in St. Luke's Hospital, twelve. Confirmed with primary operation in St. Luke's Hospital, five.

So, included in this series up to 1925 there were only three in the 175 cases followed, or 1.6 per cent. (See Table V.)

Studying this group, which is of particular interest to me, there were five cases which were diagnosed after partial gastrectomy. Of these five cases, diagnosis was confirmed by operation or autopsy in three, showing that the gastrectomy does not prevent the formation of marginal ulcer.

TABLE V

Gastrojejunal, jejunal or marginal ulcers

Total cases diagnosed from 1916 to December 1929		22
Total cases diagnosed and confirmed from 1916 to December 1929		12
Total cases diagnosed with primary operation here		12
Total cases diagnosed and confirmed with primary operation here		5
Total cases diagnosed with primary operation elsewhere		7
Total cases diagnosed included in series up to 1925	3 in 175	1 6%
Total cases diagnosed after partial gastrectomy		5
Total cases diagnosed and confirmed after partial gastrectomy	. .	3

DR. ARTHUR D. BEVAN, of Chicago, remarked that peptic ulcer is a very common disease. The best statistics that we have now, those of Carl Hart, show that it occurs in from 10 to 12 per cent. of the adult population. In the adult, from twenty to forty-five years of age, where post-mortems are carefully made, more than half of these ulcers are healed, less than half are open ulcers In other words, it has been proven very definitely that there is a strong tendency to spontaneous cure. These two facts should be kept in mind in studying this problem. The piece of joint research that Doctor Sippy and his associates and my associates and myself made in the period from 1915 to 1925 included 2,056 ulcer cases. It was a piece of scientific research between the medical and surgical departments without any preconceived conception or idea as to what the result would be. Sippy was enthusiastic about the method of treatment which he was introducing. He had the general conception that Cruveilhier had, and which he presented a hundred years ago when peptic ulcer was first accurately presented to the medical profession, that it was due to corrosion or digestion by gastric juice, and he had the conception that peptic ulcer was due to a combination of several causes and this we finally formulated in the algebraic problem that X plus Y plus Z equals peptic ulcer, that the X was the essential cause and was represented by gastric juice containing free hydrochloric acid and pepsin, that the Y was a lesion of the mucous membrane where the mucous membrane or other coats of the stomach were so injured that they could be digested by the gastric juice, that the Z was what we might call the susceptibility of the individual to ulcer. We know that there is a very marked hereditary influence. We know that other conditions like anæmia, syphilis and tuberculosis predispose to ulcer. It is nonsense to say that we do not know anything about the etiology of peptic ulcer. An enormous amount of work has been done on this subject, as much possibly as on any problem in medicine. The most exhaustive and the most reliable article on the etiology and pathology of peptic ulcer is that of Hauser in the *Henke-Lubarsch* series on "Pathologic Anatomy and Histologie" We know quite as thoroughly what the etiology of peptic ulcer is as we do the etiology of ulcer of the leg. The conception was carried out in our study that in the treatment the elimination of the effect of the free hydrochloric acid as accomplished by the Sippy treatment is essential, and that rest is, of course, important, and that simple bland diet must remove food traumas.

The conception must be perfectly clear to our mind now that no matter whether a peptic ulcer is treated by medical management, by a lesser operation such as a gastroenterostomy or by a resection, that the same factors that produced the peptic ulcer in the first case may lead to a recurrent ulcer. There is no assurance that by resection one is going to cure a peptic ulcer.

A German colleague said that after a patient with a great tendency to recurrent

ulcer had been operated on three or four times and finally almost the total extent of the stomach had been resected and the patient had no further symptoms, "Of course if you have an ulcer of the leg and you amputate the thigh, your ulcer of the leg is gone." But there is always that tendency, and I think we to-day should realize that no matter what the treatment is, medical, gastroenterostomy or resection, there is always the prospect of a recurring ulcer.

In this group of 2,056 cases we operated on only about 10 per cent. We operated on those that were transferred to us by the medical department, the admitted medical failures. I would say to-day that in a similar series we would operate on probably twice as many.

Looking at this problem in a judicial way I would say this: that the medical man to-day who does not see a fair surgical indication in 20 per cent. or more of his cases is not doing the best by his patients. I would also say that the surgeon who does not realize that there is a strong tendency to cure spontaneously, and a very marked tendency and prospect of cure under proper medical management in probably 80 per cent. of the cases is not doing the best that he can for his patient.

Of course there will always be the difficult cases to be handled, and we must recognize the main central idea that there is such a lesion as peptic ulcer disease, that we haven't to deal simply with a single lesion, that it is a tendency which must be handled.

PROFESSOR GUNNAR NYSTROM, of Uppsala, Sweden, said, to illustrate what Doctor Bevan had said, he would report a case of recurrent duodenal ulcer in a forty-seven-year-old man, callus duodenal ulcer, resection of the antrum of the stomach, modification of Polya. While the function was not satisfactory, a gastroenterostomy was done one month after operation. After five months the patient called again. He had then a jejunal ulcer in the abdominal wall. The ulcer was excised, a malformation here and the outlet here. All went well. After eight months the man came in presenting a large jejunal ulcer just opposite the outlet. The affected loop was removed and an enteroanastomosis made; the stomach was resected so that only about one-third of it was left and a new gastroenterostomy was made.

Investigation about acidity showed that the gastric juice was taken out by the gastric fistula. The acidity rose just above to normal conditions. It was investigated every few hours through the fistula. The acidity rose slowly. The pepsin continued to be secreted after operation. This is in accordance with investigations by Perma that in fourteen cases only three showed acidity, four cases lower rates of acidity, and half the cases normal rates of hydrochloric acid. This goes to show that the opinion based on investigation that the removal of the distal part of the stomach is going to extinguish the production of gastric peptic juice is erroneous. Three years after this operation the man called again presenting two new jejunal ulcers, one in the upper part and one in the lower part. He was compelled to make another resection and made a new gastroenterostomy and with good success for these months. He did not know how it would be in the future.

This is in accordance with the rates of the recurrences of jejunal ulcer after their different operations. Jejunal ulcer follows in about 3 per cent. of gastroenterostomies in Germany. Less than 1 per cent. resections. The number of occurrences after resection has increased in the last year so it is possible that the rate will exceed 1 per cent., thus being about one-third of the number of recurrences of gastroenterostomy.

DR. JOSEPH C. BLOODGOOD said that for years physicians and surgeons had discussed the medical and surgical treatment of gastric ulcer without arriving at any definite conclusions. Frequently each has been highly prejudiced in favor of his own line of treatment. The results of surgical treatment had been shown this morning. They are not entirely satisfactory. In some instances they may be regarded as disappointing. The gastroenterologist and medical men should now present their side of the discussion after a number of cases have been followed carefully a sufficient length of time.

In the discussion of gastroenterostomy two things are striking; first, technic has

not been mentioned, and second the term vicious circle has not been employed. Such wide variations in the number of cases of obstruction, which formerly would have been referred to by the rather mystical term vicious circle, must be dependent somewhat upon variations in technic. Obstructions at the gastro-enterostomy orifice are occurring with decreasing frequency. The introduction of the posterior, no or short-loop, gastroenterostomy had much to do with this. One of the most important factors in its prevention is suturing the mesocolon high on the stomach, so that, if œdema occurs in the mesocolon, the stomach and not the suture line or the small intestine will be compressed. Obstruction can be prevented by suturing the stomach high. In cases upon which he had had to operate for obstruction or had seen operated upon, œdema, causing a rigid mesocolon, had been the cause in the majority of cases.

This œdema had been due apparently to mild infections. He knew that he was treading on debatable grounds when he spoke of clamps, but he believed that they prevent soiling, which may be the cause of a mild infection with œdema. He had seen no harm from using clamps. They facilitate the performance of the operation and render it clean.

Vicious circle clothes high intestinal obstruction with a certain air of mystery to which it is not entitled.

DR. WILLIAM J. MAYO, of Rochester, Minn., It is interesting that at a meeting of the American Surgical Association thirty years ago a remarkable contribution to the subject of duodenal ulcer was made by the president of the Association, Dr. Robert Weir. I perhaps remember it well because this was the first meeting of the Association I had attended as a Fellow, having been elected to fellowship the year before. Doctor Weir's presidential address was based on a summary of all the reported cases of perforated duodenal ulcer up to that time, a total of fifty-one, and he emphasized what now is known to all; namely, the relation of the symptoms that preceded the perforation to the condition that was found at operation. He brought out clearly the point of prolonged hyper-acidity, the relief obtained by taking food, and those classical symptoms that we now know well. I had seen a few cases of acute duodenal perforation before this time. It is interesting that in the first two cases in which we operated for acute perforation of the duodenum the pre-operative diagnosis was acute appendicitis. It so frequently happens that in the perforations of duodenal ulcers the duodenal content which escapes into the peritoneal cavity gravitates into the right inguinal fossa. It was only as we explored in these cases and found the appendix normal that we traced upward and found the perforated duodenum.

Judging from what has been brought out to-day, surgeons have reached something resembling unanimity of opinion regarding operations on duodenal and gastric ulcers. First, a considerable percentage of patients with duodenal ulcer get along very well if they are so situated that they can carry out the dietetic régime that is advised. Unfortunately many patients, because of poverty or nature of employment, are not able to care for themselves properly and must come to operation early. Also in many cases in which surgical treatment should be given, it is delayed, to the disadvantage of the patient by prolonged medical treatment, and repeated "cures." The patients with perforation, hæmorrhage, obstruction, and conditions which result in pain, malnutrition, and chronic dyspepsia should have surgical treatment.

When it is considered that the part of the duodenum that is involved in ulcer is functionally not of great importance, it seems a pity to advise removal of a large part of the healthy stomach for its cure. Few of us would ourselves submit to extensive gastrectomy for duodenal ulcer as a primary operation, or permit this operation to be performed on members of our families, inasmuch as local operations, gastroenterostomy, or partial duodenectomy, one or both, give so high a percentage of satisfactory results.

My opinion is still further strengthened by the fact that at the Clinic we are seeing about the same percentage of marginal ulcers after partial gastrectomy for ulcer of the duodenum that we saw following gastroenterostomy. The great majority of the operations of partial gastrectomy were not done at the Clinic, and we assume they were

well done. An important consideration is that if gastroenterostomy is done, and later gives rise to trouble it can be disestablished. Many patients, relieved by gastro-enterostomy in whom a gastrojejunal ulcer developed later have been found, on secondary operation, to have a soundly healed duodenal ulcer, without obstruction, and after the gastroenterostomy has been disestablished have gone for years without further symptoms.

I am sorry for the surgeon who again must resect a portion of the remaining gastric pouch, following partial gastrectomy for duodenal ulcer, to rid the patient of a secondary gastrojejunal marginal ulcer. We have had such experiences, not only once, but three or four times in the same patient.

There is rather general agreement between the clinician and the surgeon that ulcer of the stomach is a more serious disease which cannot always be distinguished from carcinoma.

About twenty-five years ago in a report of the first series of resections performed for gastric carcinoma in the Clinic it was shown that in more than 60 per cent. carcinoma probably had developed on a basis of gastric ulcer. In our later experience, although the percentage of cases in which the histologic examination of excised carcinomas of the stomach gives evidence of preceding ulcer varies in different series, evidence that gastric carcinoma has developed on some type of demonstrable precancerous disease, such as ulcer, is present in 25 per cent. Even those investigators who do not believe that carcinoma of the stomach often has its origin in ulcer, admit that carcinoma develops on a basis of ulcer in a percentage of cases, which Hurst, of Guy's Hospital, London, puts at about 20 per cent. It must be borne in mind that in a large percentage of cases the disease is so extensive when resection is done as to render it impossible to speak definitely of what preceded the carcinomas, just as it is a matter of common experience that purely clinical evidence as to the origin of carcinoma is likely to be fallacious.

DR. EUGENE H. POOL, of New York, presented some figures from his service at the New York Hospital. There has been surprising divergence in the reports in regard to immediate mortality. He was especially surprised to hear the statistics from one of the New York Hospitals and then to hear Doctor Felter's report of results. He reported only 2 per cent. mortality which is in striking contrast.

Doctor Pool's figures were 188 cases operated on in the wards by the staff of the second surgical division of New York Hospital for chronic duodenal ulcer. These do not include 142 acute perforated ulcers operated upon during the same period.

The follow-up findings are about the same in all these papers and statistics. They had in duodenal ulcer apparently 85 per cent. cures, but it is not on that feature he wanted to dwell. It is in regard to the deaths in simple gastroenterostomy, and here he had 119 cases, with nine deaths, or 7½ per cent. almost identical with Doctor Gibbon. When he read his causes of death, Doctor Pool also was very much impressed with the similarity to his record.

The causes of death in my series are as follows: Subphrenic abscess; pneumonia; intestinal obstruction; general peritonitis; shock; suppurative pericarditis; delirium tremens; otitis media, followed by thrombosis of the lateral sinus and septicæmia.

A number of these cases could scarcely be attributed to the operation *per se*. Hanrahan naïvely said in the last paper, if one could eliminate the sixteen deaths due to obstruction it would cut down the mortality materially, but how can one, if those cases died in the hospital? How can one get away from the fact that of 119 cases, there were nine deaths or 7½ per cent. mortality?

The sad part of this discussion he was reminded of when Dr. William Mayo was speaking. He sounded a warning against resection. All these records of mortality will be used as a strong argument by the advocates of resection for duodenal ulcer, but they must analyze their deaths as honestly as we have. If they have an otitis media in the hospital and the patient dies, he has got to be put down as dead. He did not believe they get away with such low mortality as they claim for extensive resections.

Dr. J. Shelton Horsley, of Richmond, Va., said that with very few exceptions, the cases in his paper were of patients that had been treated medically, unsuccessfully, and had consequently been operated upon. He operated more promptly on gastric ulcers than on duodenal ulcers.

He thought it rather unfortunate to have too sharp a distinction between the medical and the surgical treatment of peptic ulcer. They should go hand in hand. If the medical treatment can cure a peptic ulcer in a reasonable time, obviously it should be adopted, but why continue it indefinitely when no permanent curative results have been accomplished? On the other hand, when operation has been done, it is also obvious that medical treatment should be adopted to help the stomach recover. It is just as reasonable to use medical treatment, which consists largely in the regulation of diet to give the stomach rest, to assist in the recovery of a stomach that has been temporarily crippled by operation, as it is to use a splint on a fractured bone that has been accurately set until the bone has become strong again.

It seemed to him that the operation should be adapted to suit the lesion. Other things being equal, it is better to have two or three conservative operations with the prospect of a radical operation later in a very small percentage of cases, than it is to do an extremely radical operation such as a subtotal gastrectomy as a routine in all peptic ulcers.

Doctor Gatewood, of Chicago, remarked that several years ago Doctor Balfour called attention to the fact that their mortality was considerably reduced by pre-operative preparation. That was brought out in Doctor Gatewood's survey of these cases rather forcibly. In addition to that, it has been customary to give all of his patients a certain amount of post-operative medication. That is very much worth while if one expects to increase the percentage of cures after any type of gastric surgery.

Dr. Donald C. Balfour, of Rochester, Minn., thought there are three or four things that might be said in trying to summarize this symposium. In the first place, it is obvious that no operation will give perfect results in all cases of such a chronic disease as peptic ulcer, a disease in which the surgical management is usually carried out after all other methods of management have failed. The point which Doctor Douglas brought out in a very emphatic way was that recurrent ulcer may, and does, take place after any type of operation.

It is a fatal mistake to try to establish one operation for all types of peptic ulcer. So we finally end up with the fact that the best results that are being obtained by the surgeon who knows how to select the patient for operation and knows how to select the operation. He subscribed very emphatically to what Doctor Judd had said about the indications for pyloroplasty and excision. If one can get a good job done with that type of operation, the patient is in a position in which one would like to be oneself if one had a similar condition. If the patient should develop recurrence afterwards one is in a favorable position for carrying out further surgical procedure.

As far as the details of this symposium are concerned, leaving aside the mortality rates, there is a very definite conformity of results of gastroenterostomy in chronic duodenal ulcer. That is something one ought to remember because when the American Surgical Association presents such figures as these from various members, and they all run between 85 and 90 per cent., it is convincing evidence of what can be accomplished in chronic duodenal ulcer by indirect operation alone.

An impressive point in gastric ulcers was the extraordinary results which might take place in those lesions in which it would have been a very mutilating operation to remove the lesion anyway. Excellent results frequently follow an indirect operation alone. Seventy-nine per cent. of those patients reported themselves as being relieved of their symptoms, and in a great many of them the lesion had disappeared.

Finally, he thought the most fundamental point in this whole question of conservative versus radical procedures was this, that other things being equal, that is where the same surgeon is carrying out the different procedures, there will be more patients die

following a partial gastrectomy as a primary operation than will develop recurrences, following a conservative procedure.

DR. FORDYCE B. ST. JOHN, of New York, remarked that satisfactory as the results have proven to be in this morning's consideration, the members of this organization especially cannot rest too comfortably upon those results. It would be of interest in the next five-year period to concentrate on what he had named intangible factors. He had been impressed in his study in following them in continuity with three factors: cases well six months previously will present symptoms at the given observation, temporary in many cases, but symptoms which one honestly cannot evade. Other cases will develop organic lesions such as marginal ulcer or hæmorrhage, or what not. The etiological factors in this group are becoming increasingly interesting and by no means always explained by stress and strain.

DR. JOHN H. GIBBON, of Philadelphia: thought this discussion had demonstrated the fact that the ability to perform one operation with facility does not completely equip a surgeon to deal with gastric and duodenal ulcer. Therefore, in this field as in all fields surgical judgment becomes of prime importance.

The next thing that has been brought out is the very high percentage of lung complications after these operations.

As to the rarity of jejunal ulcer, he remembered discussing this same question with the late Doctor Peck. Both agreed that probably jejunal ulcer might be due to the way in which the gastrojejunostomy was performed. At that time excision of the redundant mucous membrane of the jejunum was quite popular. They both agreed that this was a mistake and that the redundant mucous membrane of the jejunum should be used as a covering over the raw surface. Another important thing to remember is that the tight suturing, even with absorbable sutures, invites necrosis by cutting off the blood supply. Silk and linen sutures may play a part in the development of jejunal ulcers.

PHILOSOPHIC CONSIDERATIONS OF THE GALL-BLADDER*

By Charles H. Mayo, M.D.
of Rochester, Minnesota

PROBABLY the most interesting period of medicine has been that of the last few decades. So rapid has been this advance, as new knowledge developed, that the truth of each year was necessarily modified by new evidence, making the truth an ever-changing factor.

My consideration of such advancement relates to the gall-bladder. As yet, we do not know why animals representative of certain types of life have gall-bladders and others do not, but it is probable that if we knew the full story of intake of food it would explain some of the purposes and some of the diseases of the gall-bladder. Members of the pigeon family do not have gall-bladders and neither have certain types of fish. Most animals which live on the direct products of the soil have gall-bladders, whereas the pocket gopher, which lives and feeds beneath the soil, does not have a gall-bladder. The rat, which possibly has an intestinal tract and liver much like that of the pocket gopher, is able to make much stronger bile than that made by the mouse, which has a gall-bladder. Animals which live on leaves during the summer and mosses and dried grasses beneath the snow in the winter do not have gall-bladders, and are types which mostly cast their horns or antlers. The elephant is also a leaf-eater and is minus a gall-bladder. Absence of the gall-bladder in the human being has been noted in thirteen instances and a double gall-bladder has been reported in eight instances.

Apparently the gall-bladder is attached to the right lobe of the liver. We now know from the chemical digestion of various portions of the liver that it is exactly on the division between the right and left lobes. There is no connection whatever between the circulation of the two lobes of the liver or between their ducts. The gall-bladder is supplied by the cystic artery of which the arterial tension is that of the circulation, whereas that of the arteries in the liver is low. The necessity for an excessive blood supply to this small sac is not evident at first thought. There are one or two lymph nodes on each of the hepatic ducts; if we know their normal size, their enlargement indicates infection or over work. The one or two lympth nodes on the common bile-duct are enlarged in the presence of disease of the gall-bladder, of ulcer of the duodenum, or of disease of the pancreas. The left lobe sometimes is wholly missing; then the gall-bladder is attached to the right lobe but is found near the median line of the body. If the right lobe is missing, then the compensatory hypertrophy which occurs when either lobe is missing forces the gall-bladder to a deep, posterior position. This little sac, in the human being, holds from thirty to forty cubic centimetres of bile, which is darker and thicker than that in the biliary ducts; in fact, it is the residue of

from 250 to 400 cubic centimetres or more of bile which went into the gall-bladder. The bile in the gall-bladder is from eight to twelve times more concentrated than that which has just been made by the liver and is found in the hepatic ducts. This concentration is apparently wholly due to filtration of the fluids of the bile which pass through the wall of the gall-bladder into the venous circulation or the lymphatic channels. Herein is seen the benefit of the large arterial supply to the gall-bladder, the mucous membrane of which, secreting colloid mucus, maintains the solvency of bile salts and pigment; therefore anything which would add to the function of filtration of the gall-bladder or which would reduce its blood supply would contribute to failure of maintenance of solvency, and sediment would appear. If the end of the common bile-duct is blocked, the gall-bladder and ducts are soon distended with granular, thick bile, and deep jaundice appears. In a few weeks, however, when the liver can force no more bile into the ducts, this mucus redissolves the biliary sediment, and the so-called white bile appears in the gall-bladder and ducts. Inasmuch as the gall-bladder cannot get any bile without closure of the papilla of the common bile-duct, which forces the bile backward through the cystic duct, conditions in the intestine might arise which would add to spasm of the sphincter of Oddi and would increase the work of filtration in the gall-bladder. The common bile-duct has low tension at its outlet in most of the types of life in which the gall-bladder is absent. However, in some the tension rises at times to seventy milligrams and it fluctuates to a far greater degree if a gall-bladder is present. Through stimulation of the liver, bile should flow on the taking of food, and as long as there is food in the stomach or duodenum. After food has passed the duodenum, there is great lessening of hepatic function, and until the next meal, most of the bile should be handled by the gall-bladder. In those who have excessive spasm of the sphincter of Oddi there is usually fluctuation in color of the bowel movements from light to dark. The periods are usually of two or more weeks' duration. Rarely, in my experience, has this spasm been sufficient to produce mild jaundice, as reported in German literature, yet it may account for variations in the percentage of bile in the blood.

It was formerly believed that the gall-bladder caused disease of the liver, and it is probably true that the severity of hepatic disease is often increased in the advanced stages of mechanical obstruction involving the common bile-duct. We now believe it is more probable that, through hepatic tension, the liver becomes harder and darker, and that the thin, sharp edges become rounded. Often there is evidence of excessive filtration on the surface of the liver about the gall-bladder, and deposits of connective tissue. At times, local hepatitis on the surface, resulting from the prolonged over-filtration, causes adhesions to the bowel, the omentum or the parietal peritoneum. Thus, it seems that the liver is the primary sufferer in the beginning of the diseases which are finally evidenced in the gall-bladder.

Many types of life in which the gall-bladder is present are found to be subject to gall-stones. In the human being gall-stones were noted to be com-

mon, and, a few decades ago, when safer surgery became possible, exploration and various procedures were developed to deal with disease of the gall-bladder. Little attention was paid to the condition of the liver or the biliary ducts. For a number of years, in spite of adhesions and evident changes in the gall-bladder, the tangible evidence of gall-stone was the essential indication for opening the gall-bladder, and it was drained and preserved as a necessary organ unless it was so seriously diseased that it was impossible to preserve it. When it was preserved, many patients were not quite well, and some had a recurrence of gall-stones.

In considering the diseases of the gall-bladder itself, cholecystitis comes under consideration. Often this condition is shown by thickening of the walls of the viscus, with adhesions to other structures which evidently come from inflammation in the gall-bladder. This may have become chronic, and there may be changes in the mucous membrane, commonly called strawberry gall-bladder. The characteristic small spots often show through the wall of the gall-bladder or, with bacterial irritation of local areas, papillomatous growths in the mucous membrane may be caused. Small stones are not always felt by palpation of the gall-bladder with thickened walls that is under some tension. The infected gall-bladder may empty its toxic bile into the intestine from time to time, and this structure is probably the carrier of *Eberthella typhi*. Rosenow showed that the gall-bladders of typhoid carriers and of those infected by *Escherichia coli* or streptococci again take up their function after subsidence of the acute or subacute attacks of inflammation. The organisms are then found by culturing the submucous tissue. If general evidence of marked chronic hepatitis such as I have described is present, the biliary tension can certainly be lowered by removal of the gall-bladder together with half of the cystic duct. This apparently reduces the tension to that found in animals which do not have gall-bladders. Although the hepatic and common ducts may be distended, they become distended but little more, if any, when the gall-bladder is lost. Probably half of the persons who reach the age of fifty years have considerable evidence of chronic hepatitis; it is said that in every hundred of these, twenty have marked evidence of cholecystitis and twelve of the twenty have gall-stones.

Among the multitudinous functions of the liver, separation of the heavier metals is one. After it is prepared by animal cells, the iron is found ready for the use of the living cells, and the juices of the liver are now prolonging the lives of countless sufferers from pernicious anæmia. Rowntree pointed out years ago, when testing the function of the kidney and the liver, that the chlorides were not handled by the kidneys but by the liver. This division of chemical function led to modern clinical investigation of conditions and functions of the gall-bladder, by means of dyes that are impervious to Röentgen rays being given by mouth or intravenously. Mann, in his experimental work on the possible dangers of an excess of Carrel-Dakin solution (sodium hypochlorite) in closed cavities, showed that intravenous injection into animals of five to ten cubic centimetres for each kilogram of body weight of this

solution exerted its destructive effects on the gall-bladder and produced round-cell infiltration with inflammation which, microscopically, resembled that due to bacteria. Injection of twelve cubic centimetres of this material for each kilogram of body weight usually caused death of the animal.

The liver has the greatest power of regeneration of any structure in the body; apparently its cells are constantly changing, being destroyed and renewed. Combinations of carbon with the chlorides produce extensive destruction of the hepatic cells and, if their administration to animals is long-continued, changes resembling chronic cirrhosis are caused. Through experimental research and clinical observation it has been proved that surgery for disease of the liver, although directed against an extensively diseased gall-bladder, is a dangerous procedure. The practical observation is that when a hardened, granular or cirrhotic liver is present, one of its major functions must be thought of; namely, the handling of sugar. If it is felt that sugar cannot be mobilized, the patient should be given a solution of glucose intravenously several times in the first four days following operation. When cirrhosis is produced in animals, life is maintained very comfortably with a limited amount of hepatic substance, so long as plenty of carbohydrate, in the form of syrup, is given daily. When meat is fed to them, ascites develops and they quickly die from toxemia, the result of reduced hepatic function.

The condition of the head of the pancreas should be noted in cases of hepatic disease, for the pancreas is directly connected with the liver in function and it empties its secretion through the same outlet as the liver. A diseased liver may cause secondary changes in the pancreas. The head of the pancreas partly encloses the lower part of the common bile-duct, and, through pancreatic disease, sometimes causes obstruction of the common bile-duct. If the head of the pancreas is large, irregular, and hard, interstitial pancreatitis may be present. If the head of the pancreas is smooth, hard, and large, the disease is of the interacinar type, which may be associated with acute pancreatitis, hæmorrhage, high temperature, fat-necrosis and ascites with blood-tinged fluid. Less serious conditions are frequently found in the pancreas. A diseased pancreas may cause colic referable to the biliary ducts after the gall-bladder has been removed. A more serious condition that may be present is carcinoma.

I would urge that, at exploration, the liver be more carefully inspected, and that the size of the glands on the ducts be examined to see if removal of the gall-bladder is not warranted in many of these cases in which there is need of relief of hepatic tension. In these cases, there may not be much to be found in the gall-bladder, by palpation, but there may be evident disease when it is examined after removal. The disease of the liver is primary, and the gall-bladder is secondary in importance in the bodily economy. Nevertheless, it may be wise to preserve, and drain, the gall-bladder in cases of acute illness.

ACUTE CHOLECYSTITIS

By Richard H. Miller, M.D.

of Boston, Mass.

This discussion represents the results of a brief inquiry into the treatment of acute cholecystitis—an inquiry directed particularly at the question of how long one should wait before performing operation in the case of the acutely inflamed and infected gall-bladder. The study was stimulated by the observation of two cases which perforated, with serious results, while attempt was being made to improve the patients' general condition, and a subsidence of the acute condition was confidently expected.

In the first place, it is necessary to record exactly what is meant, in this paper, by acute cholecystitis. I refer to those cases with all the symptoms and signs of acute inflammation—pain, elevated temperature, pulse and white blood count, and tenderness and spasm over the gall-bladder. The gall-bladder itself is swollen, œdematous, distended; the cystic duct is occluded, almost always by a stone; and the contents consist of one or more stones, bile and mucus, and perhaps pus. These cases present a perfectly definite picture of acute infection, just as does the acute appendix, and the two conditions are analogous. One reads in the literature references to acute cholecystitis without stones; certainly this does occur, but, in my experience, by far the greater number do have stones present, and operation reveals either a stone in the cystic duct, or evidence that one has been displaced from the cystic duct during operative manipulation.

Wilensky[1] mentions acute and chronic empyemata of the gall-bladder without stones, resulting in attacks resembling acute appendicitis; Mitchell,[2] in reporting sixteen cases of perforation, says that "stones are not so often found as in the more chronic cases." W. J. Mayo[3] speaks of cases of chronic cholecystitics, either without stones, or with stones so small that they cannot be felt through the wall of the gall-bladder, which become acute and cause blocking of the cystic duct from swelling and œdema. In another study, Judd and Mentzer[4] report 1,000 cases of cholesterosis, of which one-half showed no stones; and one quarter of the cases without stones had, at one time or another, pain severe enough to require morphine; these cases were therefore acute, but I do not believe the acute picture is the same as that in the serious inflammation, to which I here refer.

I believe that most of the gall-bladder cases which the surgeon sees, which come into the Emergency Ward of the urban hospitals with an acute abdomen, are due to a stone in the cystic duct, and must be considered as potentially dangerous because of the tendency either to rupture into the free abdominal cavity, or to walled-off perforation, with an abscess in the liver or alongside of the gall-bladder. Alexander[5] has recently reported twenty cases, of ruptured gall-bladder—eight into the general abdominal cavity, and twelve walled-

off. I present later 200 cases from the Massachusetts General Hospital, of which a number show no record of stones; in fifty unselected private cases, forty-nine had stones, and the only one which did not was an acute cholecystitis associated with a subacute pancreatitis. The occurrence of an acute surgical cholecystitis without stones is, in my experience, extremely rare.

With a stone impacted in the cystic duct nothing flows in or out of the gall-bladder, but the mucous membrane continues to secrete mucus as long as it can, against the intracystic pressure. Hydrops first occurs, and then there may supervene empyema. If the gall-bladder has not been thickened by previous inflammation it distends rapidly, the circulation of its wall may become interfered with, and gangrene—the fore-runner of perforation—may result. If the gall-bladder has become thickened, it will not distend rapidly, but the subsequent intracystic infection may penetrate the wall and result in a contiguous abscess. Halpert[7] states that under stress the muscular layer of the gall-bladder not only hypertrophies, but herniæ of the mucosa through pouches in the muscular wall can be seen—a condition which would seem to predispose to perforation. The rapid distension of a thin gall-bladder causes excruciating pain, not easily controlled by morphine. The slow distension of the thick gall-bladder causes much less pain, and it can usually be controlled without difficulty. It must not be forgotten that a pancreatitis, of greater or less degree of severity, may supervene; according to Colp,[6] gall-bladder disease precedes pancreatitis in 85 per cent., but in 1280 cases of gall-bladder disease pancreatitis occurred in only 2.6 per cent.

Our teaching has been to allow these cases time to subside, so that operation may be performed when acute infection is not present. This has two advantages: first, the patient will stand the operation better; and, second, the chances of being able to do a cholecystectomy, rather than cholecystostomy, will be greater. Following out this idea, I watched one case in a comparatively young woman who had very severe pain, and the gall-bladder perforated while we were preparing for operation, and the patient eventually died. A second case perforated the gall-bladder under smiliar conditions, and at operation there were found not only a bile peritonitis but profuse hæmorrhage from a small artery in the gall-bladder wall; this patient recovered. The next case in point was one in which immediate operation was performed and a hugely distended gall-bladder, greenish-black at the fundus, and about to perforate, was found and drained, with recovery. These cases are, of course, exceptional, but they instigated this investigation. They satisfied me that a confident policy of "laissez-faire" was distinctly dangerous, and led me to question the general policy of postponing operation in these cases.

Furthermore, W. J. Mayo[3] says that a foul infection of the gall-bladder, associated with perforation, may occur simultaneously with an acute perforative appendicitis. He says that in case of the former, one should look at the appendix to determine its state. I have never seen this combination of circumstances, and it would not have occurred to me to investigate the appendix in the operation for a truly septic or perforated gall-bladder, for

fear of spreading the infection, but if the two conditions tend to occur together, it would certainly be an additional argument against delay in operation in the seriously acute gall-bladder.

If a truly acute gall-bladder is treated conservatively, one of three things may happen: (1) subsidence of the infection without destruction of the wall of the gall-bladder; (2) perforation with local abscess; and (3) perforation with general peritonitis. I question whether our ability to predict what may be the outcome is dependable enough to warrant our waiting, on the theory that the first of these events, retrogression of the process, will take place.

I have selected for study 200 cases, operated on for acute cholecystitis, from the records of the Massachusetts General Hospital. They were picked out in chronological order, being the last 200 in the card catalogue, and they were not chosen for any especial characteristics they might show. Of these 200 cases 160 gave a positive statement that stones were present. In forty, or 20 per cent., no note was made of stones. I believe this figure to be inaccurate, and that there were not even as many as forty without stones; probably in at least a few of these cases the operator neglected to note their presence when he dictated the account of the operation.

In these cases there were seventy-four, or 37 per cent., in which there were no adhesions about the gall-bladder, and nineteen, or 9.5 per cent., in which the note about adhesions was doubtful of interpretation. The fact that between one-quarter and one-half of the total number were not walled off is a fact which demonstrates the possible danger of spreading infection in the event of perforation.

Twenty-seven cases, or 13.5 per cent., died, their average age being 52.8 years. In these fatal cases the average duration from onset to operation was 15.0 days, and in the other 173 who recovered, the average time from onset to operation was 8.3 days. I went over the figures carefully, because it was, in few instances, difficult to be sure of these lapses of time; I believe them to be, on the whole, accurate. The length of time seems long, and in many instances this was due to the fact that the patients were sick at home many days before they came to the hospital. In any event, they show a striking difference between the two groups, the fatal cases having been given palliative treatment a whole week longer, on the average, than those which got well.

Of the fatal cases eight, or 30.7 per cent., had local perforation, none had general peritonitis, and four were doubtful. Furthermore, six, or 22.2 per cent., had no adhesions, seventeen did have adhesions, and in four there was no note.

The operation consisted, in the twenty-seven fatal cases, of cholecystectomy in fourteen and drainage in thirteen—practically equal numbers. In the 173 who recovered, complete removal was done in three-quarters—130, or 75 per cent. These figures prove nothing—one might interpret them to

favor removal instead of drainage, which would, of course, be a false conclusion.

I look on the above findings, though they are not striking, as furnishing support for the contention that inconsiderate procrastination in these cases may be poor judgment.

The general dictum that a septic process, anywhere in the body, should be drained, without undue delay, seems to me to hold true in infection of the gall-bladder. There are certain objections against precipitate operation: first, the patient's condition may be poor, and require amelioration; second, an operation performed in a very acute stage may necessitate simple drainage rather than the preferable cholecystectomy. In regard to the first, I would say that, without question, proper medical care should at once be instituted, and pre-operative measures should be undertaken, such as care of the heart, administration of fluids and similar procedures. In a desperately sick case, operation may be contraindicated, just as it may be in certain cases of extreme peritonitis due to a perforated appendix. In regard to the second, the possibility of the operation having to be limited to drainage, I believe that the doing of the operation in two stages may be preferable to waiting with the hope of doing it all in one; if the gall-bladder is not too badly diseased, and all stones are removed, a second operation may not be necessary; and if a second operation is necessary, the fact the previous operation has been performed does not make it much more difficult. The operation in the acute stage is best performed with some other anæsthesia than ether; spinal anæsthesia is successful in many cases; a very satisfactory method is the use of local anæsthesia supplemented, when necessary, by nitrous oxide; in this instance the pre-operative use of morphine and scopolamine is of great value. An attempt should always be made to determine whether there is a stone in the cystic duct, and, if there is, to dislodge it. I would say that a delay of twelve hours, for the administration of fluids, and other pre-operative measures, should, where possible, be allowed; but not in the presence of very acute symptoms.

My experience, and the scrutiny of the above cases, lead me to the conclusion that, when confronted with the the acutely infected gall-bladder, the surgeon's attitude should not be, "How long shall I postpone this operation?" but "Why should I not operate now?" In the presence of definite subsidence of symptoms and signs of which the surgeon is sure, and with the patient's condition good, operation may be safely put off. If, on the other hand, there is a persistence of temperature, tenderness and spasm; and, particularly, and most important, if there is severe pain, not easily controlled, surgical intervention should be undertaken without delay. In cases in which the patient's condition is questionable, the surgeon should not allow himself to be tempted into complete removal of the gall-bladder. In these instances simple drainage is not an operation to be deprecated; it may be the very best thing, and may represent the first stage in a life-saving pro-

cedure, comparable to preliminary cystostomy in the acutely obstructing prostate.

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EXTERNAL AND INTERNAL BILIARY FISTULÆ FOLLOWING CHOLECYSTECTOMY

By Frank H. Lahey, M.D.

of Boston, Mass.

In 1923,* we published our experiences with our first two transplantations of complete external biliary fistulæ. We have now done the operation upon ten patients, with the following results. Six are well and free from
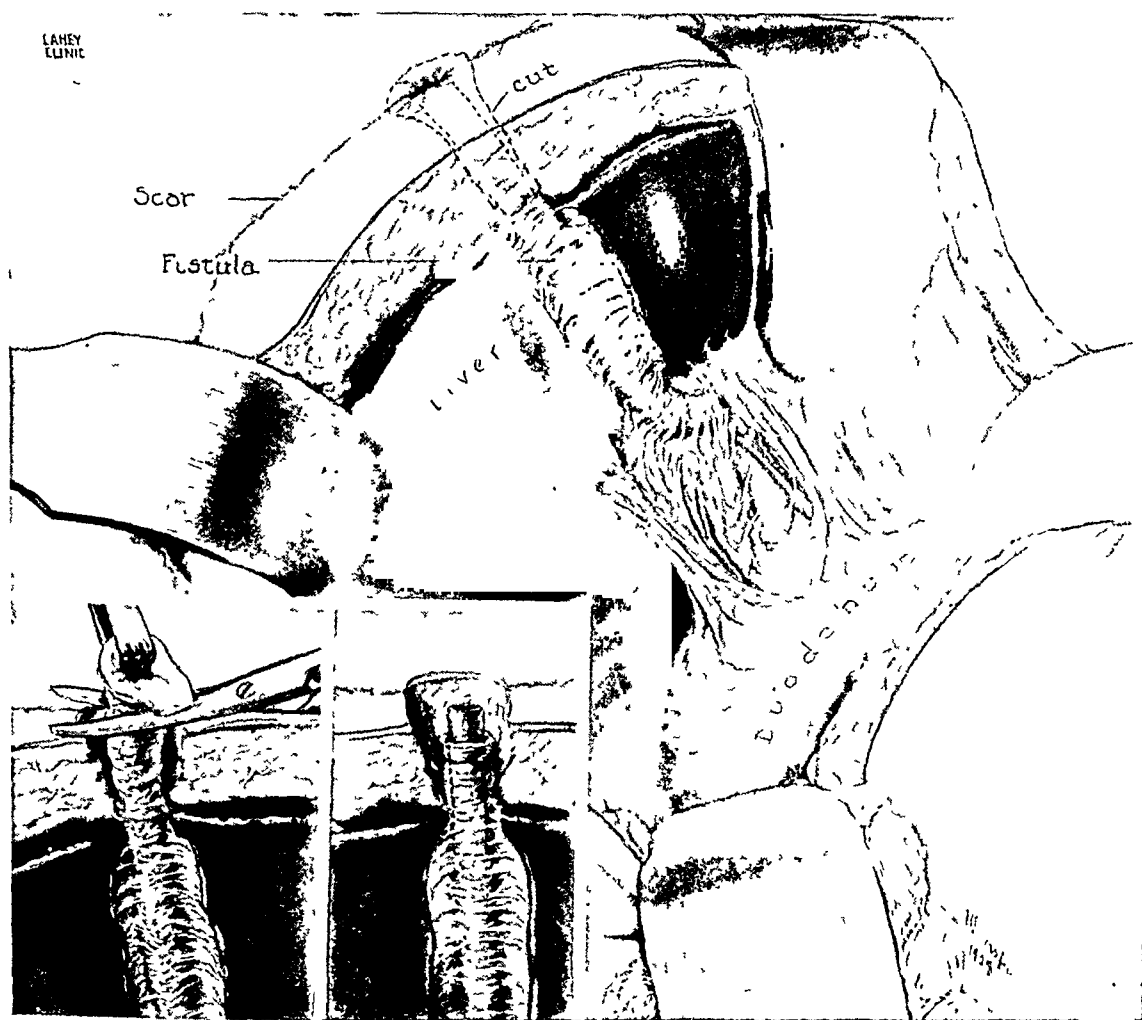
Fig. 1.—Showing diagrammatically the fistulous tract running along the bed of the liver and in dotted lines the plan of coring it out of the abdominal wall. Inserts showing the fistulous tract cored out of the abdominal wall and in one the button of skin being cut away; in the other, the small section of rubber tubing tied into the end of the fistulous canal.

symptoms. One has been a complete failure in that the complete external biliary fistula has returned. She will have another attempt at transplantation in three months more. One is a partial failure in that she is suffering from intermittent frequent attacks of biliary obstruction or infection so

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* Implantation of Biliary Fistula into Duodenum, Journal of the American Medical Association, March 31, 1923.

that she does not enjoy life, and will probably require reëstablishment of the external biliary fistula. Two died following the operation.

We have published the operative plan as we have employed it, and have laid down a few rules which we have learned as the result of our experiences with these cases which may be helpful to others. The most important of these is, we believe, that the fistulous tract may be cored out of the abdominal
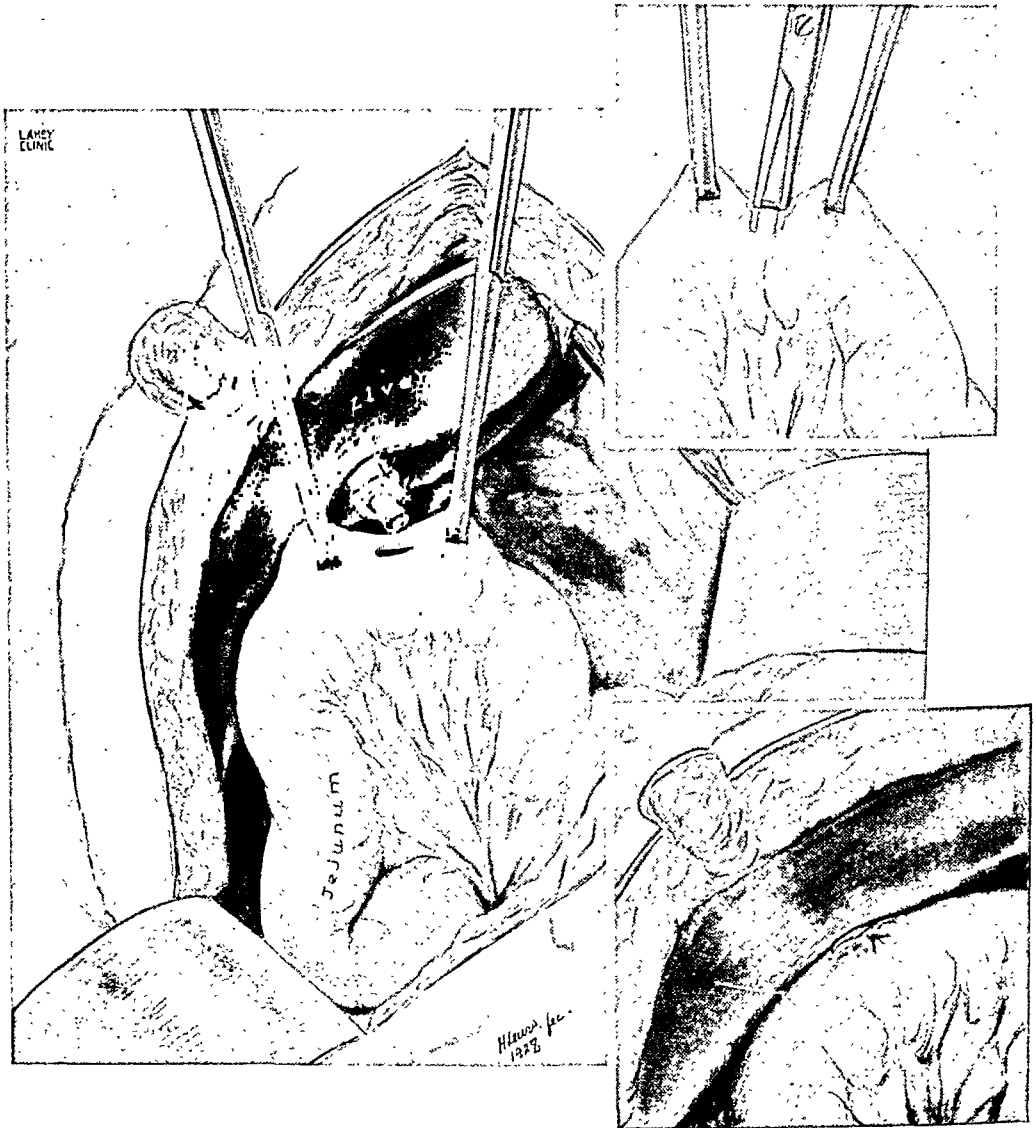
Fig. 2.—The anterior surface of the liver freed from the parietal peritoneum and turned down to meet the jejunum (or pre-pyloric gastric region) pulled up, with the opening in the intestinal canal into which the sinus is to be transplanted. One insert shows a method of making an opening when jejunum is used, the other insert showing fistula transplanted and bowel pulled well up against the liver edge so that there is no free fistula.

wall, but should not be dissected free from the under surface of the liver, from which it doubtless receives a good deal of its nourishment, which in turn helps to prevent contraction. (Fig. 1.) It therefore becomes necessary to mobilize the stomach, duodenum or jejunum so that it can be brought up to the anterior surface of the liver, the entire fistulous tract pushed into

the intestinal canal, the wall of which is sutured about it snugly by a purse-string suture, and the stomach or bowel—whichever is used—sutured to the capsule of the liver. All of the fistulous tract which is cored out of the abdominal wall is pushed through the lumen of the stomach or bowel, so that there is no free, unnourished fistulous wall between the liver edge and the intestinal wall. (Fig. 2.)

We have learned also that the production of complete external biliary fistulæ is by no means a simple procedure, and in dealing with the ten cases
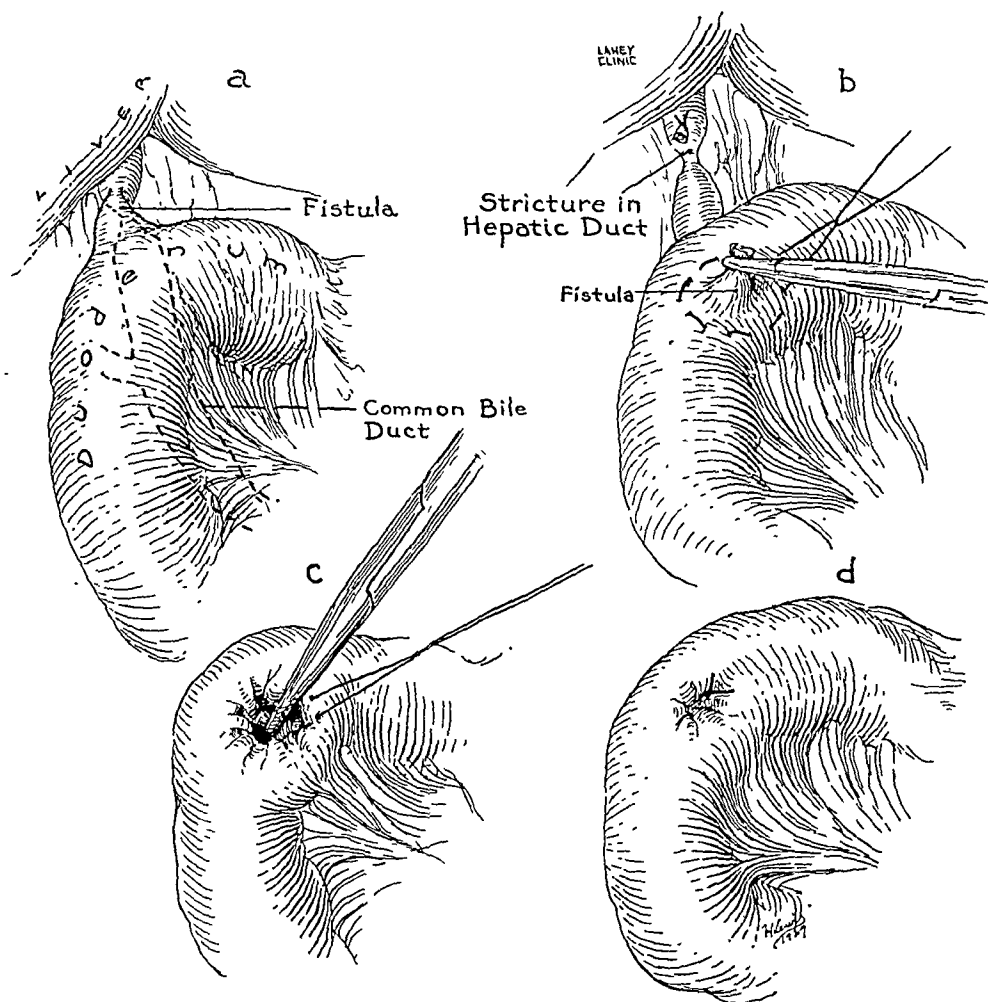
FIG. 3.—Diagrammatic illustrations of a spontaneous internal biliary fistula between the hepatic duct above a stricture and the duodenum. a, Showing fistula unseparated. b, After separation of the fistula and a purse-string suture in the duodenum for inversion. c and d, Closure of the fistula and the duodenum.

in which we have attempted to produce complete external biliary fistulæ, we have encountered and demonstrated at operation four cases in which spontaneous internal biliary fistulæ had occurred, the duodenum or stomach attaching itself to the hepatic duct above a stricture and a small and inadequate spontaneous fistulous canal being established between the two. In all of these four cases, the spontaneous fistulous canal was not of sufficient size to prevent back pressure and jaundice, and in each case it was necessary to detach these spontaneous fistulæ and to establish complete external biliary fistulæ. (Fig. 3.)

In our experience in establishing these complete external biliary fistulæ, we have had some surprising occurrences. In one of our earliest cases in which the common and hepatic ducts had been completely excised at a previous operation elsewhere, a very satisfactory preliminary external biliary fistula was established by suturing a large catheter into the hepatic duct where several months before it had been cut across just at the point where the hepatic divided into right and left branches. Bile drained well through the tube for two weeks, at which time the tube came out. For a few days there was good external biliary drainage through the external biliary fistula without the tube, when suddenly all external biliary drainage ceased, the stools became colored with bile, and the patient was not jaundiced. We were considerably disturbed by this first occurrence of this event in our experience, and presumed that either we were wrong in our observation that the entire hepatic duct had been excised, or a spontaneous internal fistula had been established. Within a few weeks bile ceased entering the intestinal canal, the patient returned to the hospital deeply jaundiced, and was reöperated upon. Again a complete obstruction was found in the hepatic duct, and again a tube was sutured into the hepatic duct and an external biliary fistula established. Again, after the removal of the tube, the external flow of bile ceased, the stools became colored, and quite evidently another spontaneous internal biliary fistula had been established. Again at the end of a few weeks bile ceased entering the intestinal canal, the patient was deeply jaundiced, developed bleeding from wound granulations, and later died without further operation.

We have in contradistinction to this experience two other much more satisfactory patients—one who came to us with a post-operative, very narrow stricture of the hepatic duct due to that structure having been clamped at the previous cholecystectomy (done elsewhere), in whom a complete stricture followed a plastic repair of the strictured duct, and in whom we later produced a complete external biliary fistula. The other patient came to us with complete loss of her hepatic duct following a cholecystectomy done elsewhere. In both of these cases, following the production of complete external biliary fistulæ by suturing a tube into the hepatic duct, soon after the removal of the tubes completely satisfactory spontaneous internal biliary fistulæ developed, as was evidenced by the sudden stopping of all external biliary discharge and the stools becoming well colored. Both cases are in very satisfactory condition—one at the end of three months and the other at the end of twelve months. No jaundice has appeared in either case, the stools have remained well colored, and both patients are in excellent health.

It is evident, then, that while some spontaneous internal biliary fistulæ may be so situated and possibly of such calibre that they will function satisfactorily and not contract, other less satisfactory spontaneous internal fistulæ will occur, will function as internal fistulæ long enough to permit the external fistula to heal, and later contract and close, necessitating reoperation and, as in one of our first cases, again exposing the patient to the

same danger of closure following the production of a second external biliary fistula.

As we suggested in the publication seven years ago of our description of our first two experiences with this condition, we presume that complete external biliary fistulæ remain open from the fact that the secretory pressure of bile is in all probability greater than the ability of the vascularized scar tissue in the sinus tract to contract. The balance of control in this situation must, however, be within quite narrow limits, and when in complete external biliary fistulæ even a very small spontaneous internal biliary fistula is established between the duct and the duodenum, pressure within the fistulous tract distal to the spontaneous fistula becomes lowered and the ability of scar tissue in the external sinus tract then controls the situation and contraction and closure of the sinus results.

The explanation as to why some spontaneous internal fistulæ remain open satisfactorily and why some close spontaneously, and as to why complete external biliary fistulæ do not close can be approached only upon a problematical basis.

It seems at least probable that external biliary fistulæ, as we first suggested in our original article, may well retain a greater ability to resist contraction when well vascularized, as when the sinus is completely in contact with the under surface of the liver throughout its entire extent, where certainly an excellent and profuse blood supply is at hand to supply vascularization. This same feature may possibly supply the controlling factor in spontaneous internal biliary fistulæ when the duodenum or stomach attaches itself directly to the under surface of the liver over the sinus, and spontaneous anastomosis then occurs between the duodenum and the vascularized sinus in the liver bed, producing a direct fistula which will not contract as has been the case in the spontaneous internal fistulæ spoken of above. When, however, the fistulous tract burrows for any distance to reach the duodenum and a free sinus of any length unvascularized by attachment to the liver bed is established, contraction as the result of bile irritation, infection, and lack of blood supply probably then occurs.

From our experience with the production of complete external biliary fistulæ, we have learned then that spontaneous internal biliary fistulæ are at times the cause of failure of external biliary fistulæ to remain open until such time as they are ready for transplantation, and that if we wish to protect the patient against the possibility of his external biliary fistula being either completely destroyed or made ineffectual by the spontaneous establishment of a communication between the fistulous tract and the duodenum, measures must be taken to lessen the likelihood of such a calamity.

Because of our experiences with a patient who has developed inadequate spontaneous internal fistulæ, thus spoiling the external fistulæ before they could be transplanted, we have attempted to prevent this undesirable event by turning up the omentum over the duodenum and suturing its right free border to the posterior parietal peritoneum just proximal to where that

structure passes over unto the first portion of the duodenum and over the pylorus and pre-pyloric region. (Fig. 4.) We have done this now in but two cases, but we hope that the interposing of this structure between the fistulous canal and the duodenum will at least lessen the chances of the occurrence of a spontaneous internal biliary fistula and destruction or impairing of the complete external biliary fistula.

We have now operated upon one of the cases in which omentum was interposed as described above between the fistulous tract and the duodenum and stomach, and it in no way interferes with the ease with which the transplantation of the external biliary fistula can be done. Based upon our
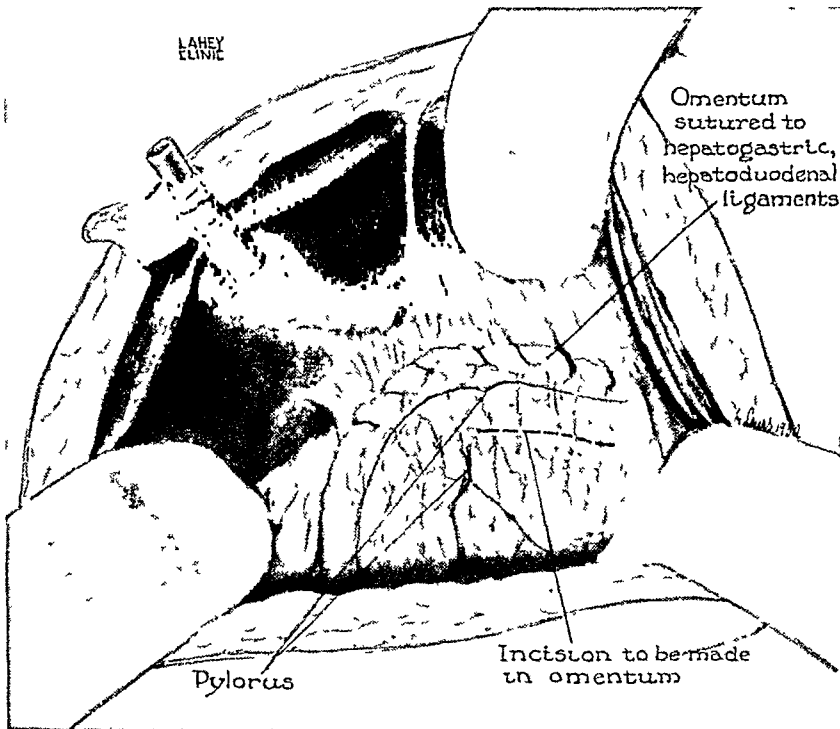
FIG. 4—The method of suturing omentum over the duodenum, pylorus and pre-pyloric portion of the stomach to the parietal peritoneum to prevent destruction of the external biliary fistula by the production of a spontaneous internal biliary fistula between the fistula in the bed of the liver and the duodenum or stomach The pylorus is shown in outline beneath the omentum placed over it The dotted line on the interposed omentum shows the incision to be made in the omentum through which stomach will be pulled for implantation of the fistula

experience with only this single case, it seems possible that it may prove of value, since it makes one able to conduct the transplantation of the cored-out fistula almost extraperitoneally.

In this case, after the abdomen had been opened and the fistulous tract prepared for transplantation by coring it from the abdominal wall, an opening in the interposed omentum was made over the portion of the stomach close to the pylorus and a sufficient amount of stomach to reach readily up to the edge of the liver at the base of the free portion of the fistulous tract pulled out with Allis forceps. The edges of the rent made in the omentum were then sutured to the base of the apex of stomach pulled

through the rent in the omentum, thus making the portion of the stomach into which the fistula was to be transplanted largely extraperitoneal. (Fig. 5.)

The stomach we believe should be employed when possible: (1) because we know from our experience with one of those cases now well seven years after transplantation of a fistula into the stomach, and from everyone's experiences with cholecystgastrostomy in carcinoma of the head of the pancreas, that the stomach tolerates the introduction of all bile into it satisfactorily; and (2) because, should leakage occur following the transplantation of the fistula, it will be of much less serious consequence if it be a gastric fistula rather than a duodenal one.

With the pre-pyloric portion of the stomach pulled out through the opening in the omentum and that structure sutured to the stomach to make
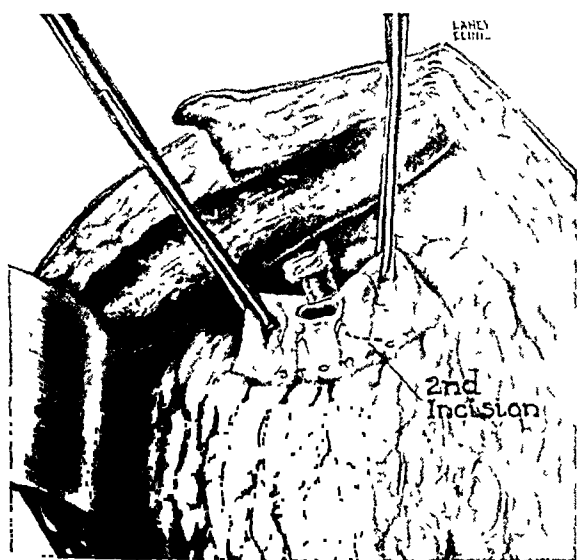
FIG. 5.—An incision has been made in the omentum and the liver has been turned down from the parietal peritoneum and an opening has been made into the stomach. The fistulous tract with a rubber tube in it is ready for implantation and the dotted line shows the point of second incision in the stomach which will expose the implanted stricture within the stomach as shown in Fig. 6.
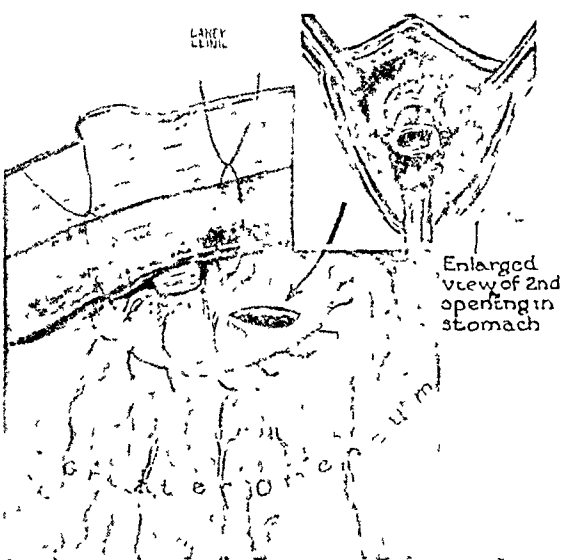
FIG. 6.—The fistula has been pulled into the opening in the stomach. The purse-string suture about the fistula is not shown but two lateral sutures approximating the stomach to the liver are shown. The counter incision is shown, in the stomach and in the insert. This incision is held open to show the fistulous tract pushed into the stomach and how it may be sutured to the mucosa within the stomach.

it extraperitoneal, a small opening is made at the apex of the pulled-out stomach at the point which will readily reach the anterior surface of the liver at the base of the fistula, a suction tube passed into the held-up opening, and any excess of gastric contents sucked out. Two stitches are passed through the capsule (and scar tissue) on the under surface of the liver, one on either side of the fistulous canal and just beneath the shelving edge of the liver. These are then passed through the stomach wall superior and to either side of the opening in the stomach, as will be seen by Fig. 6, will be the sutures which are to approximate stomach behind the implanted fistula when the stomach is brought up to the edge of the liver. It is necessary to insert these stitches before the sinus tract is implanted into the opening in the stomach, as it is not possible to get them in after the sinus has been inserted into the gastric opening.

One should have in mind our suggestion in the original article, that a short section of rubber catheter of the proper length to fill the free part of the fistula dissected from the abdominal wall and not attached to the liver should be placed in the end of the sinus, extending up that tract just a short distance beyond the free edge of the liver. The rubber tube should be inserted so that the purse-string suture in the stomach about its point of implantation may be tied tightly to prevent leakage without danger of obstructing the sinus. It should extend just beyond the free edge of the liver so that its upper free end on angulation may not cause pressure and perforation of the free portion of the sinus unattached to the liver.

The plan of pulling the fistulous tract well into the lumen of the stomach by means of a counter incision in the stomach and the fixation of the fistulous tract by sutures within the stomach is shown in Fig. 6.

CONCLUSIONS

The surgical demonstration of inadequate spontaneous internal biliary fistulæ between the hepatic duct and duodenum or stomach above strictures of the hepatic duct after cholecystectomy is reported.

The spontaneous closure and entrance of bile into the intestinal tract from complete external biliary fistulæ by undemonstrated but presumably certain spontaneous internal biliary fistulæ is reported, as is the satisfactory progress of these cases over a period of three and twelve months respectively.

The possibility of destruction of the preliminary complete external biliary fistulæ by the occurrence of inadequate spontaneous internal biliary fistulæ, together with a report of such an occurrence twice in the same individual, is reported and a plan to prevent it is proposed.

DISCUSSION: DOCTOR GATEWOOD, of Chicago, said that he had seen a number of cases in which the gall-bladder had been removed and subsequent obstruction due either to stricture or to complete cutting of the duct occurred. In the first cases he attempted by the method suggested by W. J. Mayo to bring the stomach, or the intestine, to the stump of the common or the hepatic duct. It is an operation which is time-consuming and which is difficult in patients who already have a considerable handicap. After he saw Doctor Lahey's first communication he wondered why the fistulous tract had not been used before, and since then he had used it in three instances. In each of these he had been able to use the stomach. He prefers the stomach if at all possible, first, because the gastric fistula is preferable to the duodenal in case they have a leak, and second, because the stomach seems to have less bacterial flora, and, at least from an experimental standpoint, secondary infection of the liver is not so likely to follow. In all three of these cases he had had, at least temporarily, a good result. One of these patients he reported about two years ago as being perfectly well for a year and a half. Since then she has had attacks of jaundice, and while relatively well, evidently has some intermittent obstruction. The other two patients are still well, but he was somewhat dubious as to whether these fistulous tracts will subse-

quently contract in spite of the fact that they are wide open. He could introduce his little finger into one tract at the time of the operation. He would like very much to know what Doctor Lahey's ultimate results had been in cases of this type.

DOCTOR FRANK H. LAHEY, of Boston, replied these are almost hopeless cases. The surgeon is faced with the situation that there is nothing else but this to do. At least, he knew of nothing else to do. They are not the cases in which one can do duct anastomoses and one approaches these with his mind at ease as far as end-results go. They are doomed to exist as well as they can with complete external biliary fistulæ or to take the best results they can get with transplantations. They are very likely to have more or less infection within the sinus, and certainly in the beginning to have repeated attacks of jaundice.

As to the stomach, he was certain that it is more desirable to make the transplantation into the stomach rather than the duodenum, because a gastric fistula is much less dangerous than a duodenal or jejunal fistula, and furthermore, these cases will require, he believed, more than one operation frequently. There will be failures occasionally but even though they fail, one can again excise the fistula and implant it again.

As to end-results, two cases now, one is alive eight years and another alive seven years. They have had attacks of jaundice. One has had jaundice, off and on, for several years. The other one has had no jaundice and that was a gastric implantation.

One should not be alarmed if occasionally they leak during their period of recovery. He thought that they sometimes leak because the attachment of the sinus tract to the liver may pull off because of vomiting or from moving about, but even with this leakage some of these have closed and remain dry.

BENIGN PAPILLOMA OF THE COMMON BILE-DUCT

By Alfred T. Bazin, M.D.

OF MONTREAL, CANADA

A MALE, aged seventy, occupation farmer, was admitted to the Montreal General Hospital with complaints of abdominal pain, dyspepsia and jaundice. For ten to twelve years he had suffered from attacks of severe colicky pain, latterly more frequent, and accompanied or followed by jaundice of temporary duration. The attacks have lasted three to four days and in the intervals
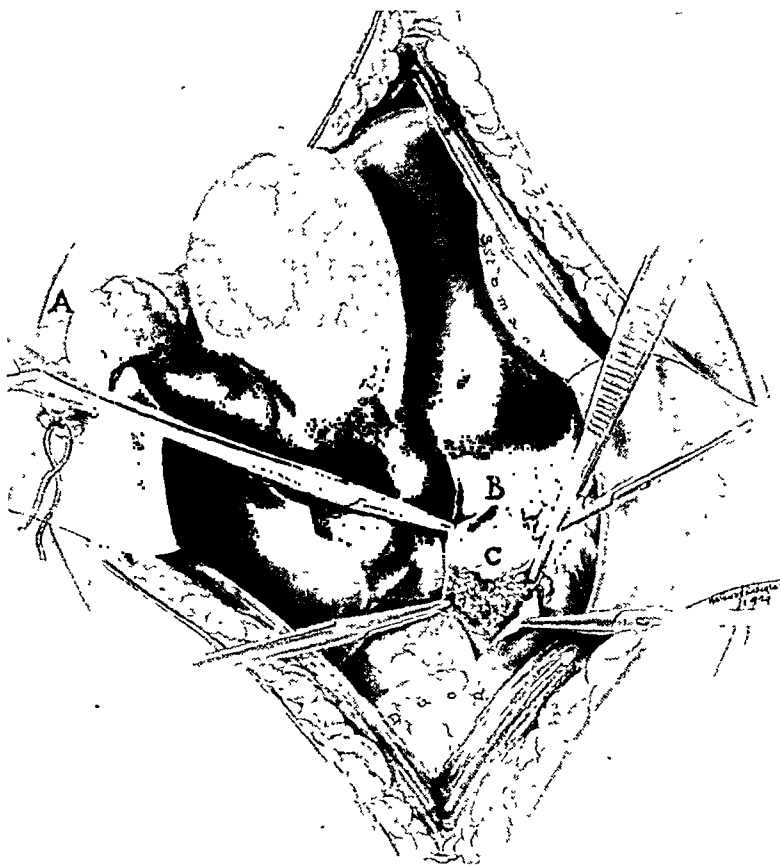
FIG. 1.—Photograph of drawing made at operation. The cystic duct A has been cut across and pulled back. Note the papilloma C in the common bile duct and the dilatation of the duct B above it. The slender pedicle of the papilloma is seen to the left side.

there have been slight dyspepsia and a tendency to constipation. An observation made by his family physician was that the attacks of colic were neither as sharp nor severe as those caused by gall-stones. His medical history is otherwise free from any illness but chicken-pox and influenza.

He presented a well-developed and remarkably preserved physique. The sclera were icteroid, chest clear, slight cardiac hypertrophy and blood-pressure 182 systolic, 90 diastolic. The examination of abdomen revealed tenderness along the right costal margin. Murphy's sign positive, Robson's point negative, liver edge palpable and slightly tender. There was bilateral crypt-

orchidism, the right testicle being in the inguinal canal, the left on the pubic ramus. There was no evidence of hernia. Urinalysis normal. Blood urea nitrogen seventeen milligrams per 100 cubic centimetres, creatinine 1.45. Fasting blood sugar .105 per cent., blood sugar time curve revealed a diminished tolerance but no delay in assimilation. Radiogram of gall-bladder after intravenous administration of iodeikon showed complete absence of all gall-bladder shadow, but no calculi.

Diagnosis.—Cholelithiasis, cholecystitis—stone in the common duct. Operation, April 10, 1929. The gall-bladder was moderately distended but the wall was free from adhesions and presented little if any alteration from normal. The cystic duct was moderately dilated but the common duct was distended to over two centimetres in diameter. The foramen of Winslow was patent and careful palpation failed to reveal any foreign body in the common duct or in the ampulla of Vater. The pancreas was normal in consistence. The junction of cystic and common ducts having been isolated,

FIG. 2.—Photomicrograph of papilloma showing epithelial lined surface of tumor A and cross sections of gland B B B B.

FIG. 3.—Photomicrograph (oil immersion) showing character of epithelial cells lining surface of the tumor "A." interglandular tissue "B" and lumen of gland "C" lined with epithelium. The epithelial cells are cylindrical and regular and have basally-placed nucleii.

the cystic duct was divided, followed by a rush of pale, almost "white" bile. As this was removed it was noted that fresh blood streaked the bile-stream and was emerging from the lumen of the duct. Swabbing pressure on the dilated duct to remove the obscuring flow of bile was followed by the extrusion of rounded pale bodies having the appearance of the component parts of a white raspberry. This revealed the true diagnosis.

The common duct was split downwards and the "red raspberry" came into view. To uncover the whole of the papilloma it was necessary to divide the peritoneum and displace the duodenum. The fragile, freely bleeding papilloma was attached to the anterior surface of the duct by a narrow pedicle, and because of the distension of the duct it was possible to remove that portion of the duct which served as the attaching base. A second pin-point sessile papilloma was observed on the posterior wall of the duct just distal to the site of the principal tumor. T-tube drainage and repair of duct were instituted. Convalescence was uneventful and recovery at present writing is complete.

Examination of the removed gall-bladder, gross and histologic, showed no

papillomatous change and little if any alteration in the structure of the mucosa. Reference to the illustrations discovers the character of the lesion, gross and histologic.

Isolated benign papilloma of the common duct is apparently rare. Benign papilloma of the gall-bladder is, on the other hand, less rare, and when present is frequently associated with papillomatous changes in the bile-duct. All of these papillomata are potentially malignant but we believe that in this specimen no evidence of malignant change presents. I am indebted to Drs. L. J. Rhea and F. D. Ackman for a search of the literature. The reported
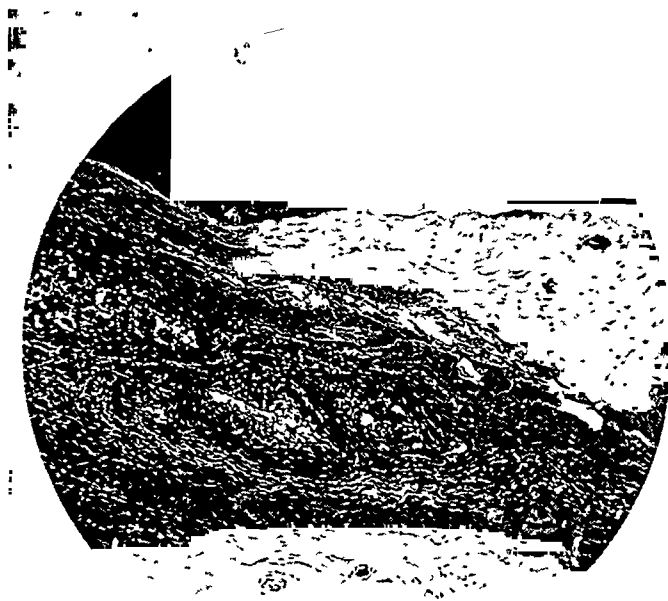
FIG 4.—Microphotograph of longitudinal section of pedicle of tumor. No infiltrating epithelial cells.

cases are variously described as polyps, adenomas, lipomas, *etc.*, and in some instances were associated with inflammatory changes, but rarely with calculi.

1. SOMMER, RENE (Beitrage zur Klinischen Chirurgie, vol. cxxxviii, p. 357, 1926–1927), deals with papillary tumors of the gall-bladder and bile passages. He reports one case of benign papilloma of the common duct, but, in the main, his contribution is a discussion of malignant papillary growths of the gall-bladder.

He points out that there is no relationship between the size of the papilloma and the degree of its malignancy or extent of the metastases.

2. KONJITZNY (Erg. d Allgem. path. und pathologischen anatomie, Bd. xiv, No. 2, p. 827, 1911), contributes a comprehensive article most of which is devoted to malignant tumors, but a small portion deals rather fully with benign tumors. He states that benign tumors of the extra-hepatic bile passages are extremely rare and such as have been described are, for the most part, in the common duct.

3. POZZI, G. (Gazetta med. ital. lombard, Nr. 49, 1880), observed a forty-year-old man with obstructive jaundice of eighty-seven days' duration which suddenly cleared followed by passage by bowel of large quantities of thick bile and six hard hazelnut-sized polyps, presumably originating in the common duct.

4. JOURDAIN (Bull. de la Soc. Anat. de Paris, vol. xxviii, p. 133, 1853), reports the post-mortem findings of a glandular papilloma of the cystic duct in a woman, forty-eight years old, who *intra-vitam* had shown symptoms of chronic biliary obstruction.

5. KRAUSE (Inaug. Diss., Kiel, 1901), mentions as an incidental finding in a case of carcinoma of the duodenum, two pedunculated mucus polyps protruding from the ampulla of Vater.

6. MONARI, A. (Clin. med. Ital., vol. xxxvii, No. 5, p. 289, 1898), described, in the common duct, three and one-half centimetres above its duodenal orifice, a scarred stricture on which were located polypoid excrescences.

7. ROLLESTON (Lancet, February 16, 1901), described a papilloma of the common duct situated upon the pressure scar of a calculus.

8. KAUFMANN, E. (Lehrbuch der speziellen pathologischen anatomie, vol. v, Aufl., Berlin, 1909), mentions a specimen in the Breslau museum that originated from gall-stones in a horse. The bile passage showed a tightly wedged cylindrical papillomatous growth.

9. CALZAVARA ("Uber Adenome des Verdauungskanals." Virchow's Archiv., Bd. cxli, p. 221), reported a pure adenoma in the orifice of the ampulla of Vater. He also reported a myoadenoma of the common duct. In both instances there was diffuse thickening of the lower segment of the bile-duct and a general inflammatory reaction in the walls of both ducts and gall-bladder.

10. ALBERS (Atlas der pathologischen Anatomie, 4, Tafel, 38, und erlauterungen dazu, 4, 1, Abt. S. 490, Bonn, 1862), refers to a case described by Ehrmann in which a bean-sized fibroma was located in the wall of the ductus choledochus causing obstruction and enormous dilatation of the proximal bile-duct and gall-bladder, with icterus.

11. HOLZINGER ("Uber ein Fibrom des Ductus hepaticus." Diss., Munchen, 1901), described an obstructing fibroma of the ductus hepaticus in a seventy-five-year-old woman.

12. VOLMER ("Ein Adenomyofibrom in der Wand des Ductus choledochus." Arch. f. Klin. Chir., Bd. lxxxvi, pp. 160–167, 1908), reported an adenofibroma. It was found as a hazelnut-sized hard tumor in the lower segment of the ductus choledochus of a thirty-eight-year-old woman, and was the cause of a dilatation of the ductus choledochus to the size of the small intestine and the gall-bladder to the size of two fists.

13. BOUISSON ("De la bile, de ses varietes physiol., et de ses alterations morbides." Montpelier, p. 137, 1843), reported a submucous polyp.

14. WARDWELL (Lancet, vol. ii, p. 407, September 18, 1869), also reported a sub-mucous polyp. He also referred to a case of a child, three years of age, in which the jaundice had come on suddenly at birth. At the junction of the cystic and common bile-ducts, he found a fatty tumor the size of a large horse bean.

15. COURVOISIER (Kasuistisch statistiche Beitrage, sur Pathologie und Chirurgie der Gallenwege, Leipzig, 1890), does not believe, however, that this was a lipoma. He thought this fat formation was due to fatty degeneration. However, he concedes that the tumor could have been a lipoma because such tumors have been found in animals.

16. NEUSSER, E. ("Ein Fall von Icterus catarrhalis mit letalem Ausgang." Stschr. f. klin. Med., vol. vii, p. 32, 1884). A man, aged thirty-nine, with a history characteristic of catarrhal jaundice, developed, during his stay in hospital, severe symptoms of hæmorrhagic diathesis and cerebral disturbance different from those of the benign catarrhal jaundice. Necropsy revealed an enormous dilatation of the common and hepatic ducts which were filled with the same fluid as the smaller intrahepatic ducts. Only the lowest portion of the common duct, about four centimetres in length, was not distended. Its wall was swollen. It was obstructed by a polypoid growth of the mucosa, the size of a small pea, situated in the posterior wall 0.5 centimetres above the ostium. Below it there was a mucous plug. Histologic examination of the polypoid growth revealed a marked proliferation of the mucous glands of the common duct without cell irregularities.

DISCUSSION: DR. EDWARD W. ARCHIBALD, of Montreal, Canada, reported a somewhat similar case to that of Doctor Bazin's. The patient, a woman of about sixty, had been operated on in a small hospital for some gall-bladder condition, the gall-bladder being removed. This was in the spring of last year. She was well through the summer, but in September began to have renewed attacks of nausea and jaundice, though without pain. She had a great number of these attacks during the winter, one every week or ten days. The jaundice lasted usually about two days. She had nausea, but never any pain. He operated and found no stone in the common duct, and only a very moderate dilatation of the common duct. A large probe, passed through the opening of the common duct into the duodenum, apparently met with no obstruction. He opened the duodenum, and then found a tiny papilloma projecting into the lumen of the duodenum, involving only the anterior half of the common duct at its opening, and he excised it. It proved to be a pure benign papilloma. The patient made an uneventful recovery. The point he wanted to make is that one should not be content when one can discover nothing in the common duct under such circumstances, but should proceed without hesitation to open the duodenum, whereupon one may be rewarded by finding something of this nature. Such small tumors cannot be recognized by palpation. Kausch, in his very excellent original article emphasizes this point, that many of these small growths may not be palpable, and that only a duodenal exploration will reveal the true nature of the obstruction.

DR. FREDERIC W. BANCROFT, of New York, said that prior to 1903 he analyzed some sixty cases of acute cholecystitis that had been treated as emergencies and operated upon soon after admission. Either cholecystectomy or cholecystotomy had been performed. In this series the mortality approached 18 per cent. The recent improvements in anæsthesia and post-operative therapy would probably bring down such emergency operation percentages to some place around 15 per cent.

While unquestionably a few cases of cholecystitis do perforate without walling off and do form abscesses, he thought that, in general, cases in which operation has been delayed for several days until the temperature has subsided do much better than when operated upon immediately. He believed one might take a middle ground. If a patient's temperature and leucocyte count does not subside within forty-eight hours, operation should then be performed, as it is obvious that either gangrene is progressing or that there may be a perforation either into the liver or into the neighboring peritoneum, with the formation of a localized abscess. From a study of the cases analyzed in 1903 he was convinced that an immediate cholecystectomy in an acute cholecystitis is in general a dangerous procedure. Moreover, with delay there is a possibility of introduction of fluids or transfusion which will help to build up the resistance of the patient.

RECONSTRUCTION OF THE BILE PASSAGES WITH SPECIAL REFERENCE TO HEPATICO-DUODENOSTOMY

By LE GRAND GUERRY, M.D.

OF COLUMBIA, S.C.

BEFORE the Surgical Section of the American Medical Association, which met in Chicago, October 12, 1918, I presented a paper on "Reconstruction of the Bile Passages." At this time we said, in part, that surgeons are occasionally forced to the necessity of reconstructing the common duct.

Surgical literature is full of case reports, and many methods have been advocated by equally as many authors—transplanting of fascia; transplanting of blood-vessels; transplanting of the peritoneal layer of the duodenum; and so on to the end of the chapter.

Experimentally, many plans have been tried on dogs with varying degrees of success. Unfortunately, however, methods that will work with apparent satisfaction in the experimental laboratory will not always be successful when applied to the human abdomen.

My personal conviction has always been that whenever direct anastomosis could be established between the bile passages and duodenum, the best results would be secured. Contraction of the transplanted tissue is the thing that causes failure in all of the so-called autoplastic reconstructions. It has been shown experimentally in the so-called autoplastic reconstructions that contraction will and does occur if there is not a proper submucosa, even though the structure transplanted may have an epithelial lining.

Whenever we can do a direct anastomosis, we are assured, first, of an ample mucous lining to the reconstructed duct, and, secondly, of a sufficient submucosa and peritoneal surface to prevent contraction. Here, as elsewhere in surgery, circumstances alter cases, and it will not be possible always to do any particular sort of operation. Conditions must be met and the method adopted which best meets the needs in the individual case.

We wish now to add to my former report of seven cases two additional case reports which are embodied in this paper.

CASE I.—A white man, seventy-three years of age, presented himself complaining of pain in the abdomen and jaundice. He had been operated upon and his gall-bladder removed, four years before. Following this operation he was well for only a very short time. His skin remained slightly yellowish, but it was not until two years ago that he began having pain in the gall-bladder region. Then followed a gradually deepening jaundice. In the past three months the pain has been quite severe, there has been more or less constant nausea and occasional vomiting, and a progressive loss in weight.

The general physical examination showed a moderate jaundice, a few coarse rales at the bases of the lungs, a blood-pressure of 180/80, and a large hernia through the scar of the high right rectus incision of the cholecystectomy. There were palpable masses in the abdomen, and the other findings were normal for a man of his age.

Except for a clotting time of six and one-half minutes, the laboratory blood findings

were not abnormal. They showed a faint trace of albumen, and an occasional hyaline or granular cast, and a very few red blood cells and pus cells.

A high right rectus incision was made under spinal anæsthesia and a mass of adhesions freed from the site of the former gall-bladder operation. The dissection of the common duct was extremely difficult, but it was finally exposed for about one and one-half centimetres along its course. It was divided just below a constriction in the duct which showed only a pin-point lumen, this stricture being at the junction of the common and hepatic ducts. The hepatic duct above this stricture was nearly two centimetres in diameter. A transverse section was done, the distal end ligated and the proximal end implanted in the side of the duodenum with a double layer of catgut sutures. Several small stones were removed which had pocketed in the area above the stricture.. A small cigarette drain was inserted and the wound closed in layers.

An uneventful convalescence followed. The temperature never went above 100° F., and the jaundice had almost entirely disappeared by the tenth day. There was, however, a very slight yellowish tinge to the skin upon dismissal three weeks after operation, though the scleræ were entirely normal in appearance.

A subsequent report on this patient's condition one month after his return home was that the jaundice had completely disappeared and that he was improving daily.

Case II.—A white woman, aged sixty-nine, was seen in consultation with Dr. J. Heyward Gibbes. She complained of pain in the upper abdomen and back, of "indigestion" and of "biliousness." The family history and past history were unessential. She stated that she had "always had a weak stomach." During the month prior to admission she had had increasing discomfort in the upper abdomen due to gas and pain which radiated to the right back and shoulder. She had more pain in the left back, however, than in the right. There was considerable tenderness in the upper abdomen for a month before she consulted her physician. The stools had also been light in color for some time.

On physical examination, there was a profound jaundice, a rather bad dental situation, a marked bilateral deafness and a slightly enlarged heart. The blood-pressure was 135/85. In the abdomen there was visible fullness and on palpation there was a crescent-shaped mass in the right half which extended well down into the right iliac region. It was smooth, oval, rather firm, and mobile, with, for the most part, an ill-definable edge, but in the region of the gall-bladder this edge was lost. The remainder of the examination failed to disclose further physical defects.

Under ether anæsthesia, a high right rectus incision was made. The liver was found occupying a very low position in the abdomen and the gall-bladder was tremendously enlarged. The head of the pancreas was indurated and enlarged. The common duct was about two-thirds the size of the duodenum. There were a few adhesions around the head of the pancreas and there was a long band of adhesions running from the base of the cystic duct up over the gall-bladder and across it.

As the pancreas was very mobile we were able to deliver the pancreatic head almost outside of the abdomen. The enlargement in the head of the pancreas was definite and unmistakable; it was clearly evident that the obstruction to the common duct was at this point. My first thought was that we were dealing with a pancreatic stone. This was found to be not true, because a small incision was made directly over the centre of the mass which was carefully stretched open with blunt forceps, and the investigation pushed to such an extent that we could be certain that no stone was present, the question then being, Was it a malignancy of the head of the pancreas or an inflammatory process? It looked macroscopically to be inflammatory. A bit of the pancreatic tissue was taken from the inside of the mass for microscopical examination. It proved to be inflammatory and not malignant. The pathological report of Dr. W. H. Plowden, pathologist for Columbia Hospital, follows:

"There was received a minute piece of yellowish-red tissue which had no particular gross characteristics.

"Microscopic sections show a tissue essentially fibrous in character. This fibrous *tissue is quite dense and there are very few infiltrating cells. Those present are small* in size, deeply staining, and almost the entire cell is occupied by the nucleus. One side of the section is covered by a single layer of tall columnar cells, as if it may have been part of a duct wall. Scattered through the tissue are a few duct-like structures lined by the same type of tall columnar cells. In a few areas are seen clumps of pancreatic cells arranged like an alveolus. None of these are seen to have direct connection with a duct. No islands of Langerhan were present in the sections."

Diagnosis.—Old chronic inflammatory tissue (scar) in pancreas.

The obstruction to the common duct at this point being apparently complete and permanent, we made an anastomosis between the lateral side of the dilated common duct and the duodenum, very much after the manner in which the above case of hepatico-duodenostomy was done.

The convalescence was entirely uneventful. The temperature never went above 99.3° F. The jaundice had entirely cleared by the twelfth day. The patient's symptoms seemed entirely relieved. The stools were normal in color and the wound cleanly healed. When last seen on March 31, 1930, this patient was apparently completely recovered.

In conclusion we wish to direct special attention to the four cases in which we were able to reconstruct by directly uniting the hepatic duct to the duodenum. There were no deaths in these cases, and all of them have obtained thoroughly satisfactory, symptomatic cures.

Naturally, then, our preference is for the operation of hepatico-duodenostomy whenever this is feasible and there is good, sound reasoning behind it. The hepatic duct is quite large when freed and isolated and has enough body to it to enable one to make a satisfactory suture anastomosis.

In this former paper of mine already referred to there is this interesting statement about one of the cases of hepatico-duodenostomy. "One particularly interesting point about the third case was that the stump of the hepatic duct was so short that, try as I might, it was quite impossible to suture the duodenum to the hepatic duct. Consequently, the gap between the two, which was about one-half inch in length, was bridged by a small rubber tube about the size of a No. 9 catheter. To my intense delight, the tube was passed about the fourteenth day, and, after a slight external drain of bile which lasted for about one month, this patient has remained well ever since."

Of course, the series of only nine cases is a small number, and the four cases of hepatico-duodenostomy comprise a still smaller number from which to draw conclusions. However this may be, we simply present the facts as they are and the surgeons who read may draw their own conclusions. Our position is that the four cases of hepatico-duodenostomy are most suggestive and furnish real food for thought.

NEUROFIBROMA ARISING ON THE PERICARDIAL PLEURA*

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AND

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FROM THE SURGICAL SERVICE OF WALTER REED GENERAL HOSPITAL

Single neurofibromas of the viscera are relatively rare as indicated by citation of such tumors in the literature. The literature, however, probably does not indicate the actual frequency as the cellular picture has led to their being designated under several names, as, fibroma, fibrosarcoma, gliosarcoma, and endothelioma. Accepting the criteria for classification of Ewing,[1] these tumors are derived from the connective tissue structures of the nerve, the neurilemma, perineurium and endoneurium, but do not show evidence of neoplastic change in the nerve elements themselves though nerve fibres are usually found in the tissue near the pedicle and occasionally filaments are seen deeper in the tumor.

Banse,[2] under the title of "Intrathoracic Fibroma, Neuroma and Fibrosarcoma," reported one case and discussed ten others, partly from the literature and partly from the clinic in which he worked at Greifswald, all of which were found in the thorax. Of these cases three were undoubtedly neurofibromas; three were spindle-cell sarcomas arising near the vertebral column and possibly had their origin from the perineural tissues; three cases were somewhat doubtful, but were apparently benign spindle-cell growths. One was a ganglionic neuroma and the other a plexiform neuroma in a case of von Recklinghausen's disease. All of these tumors were incidental findings at necropsy or, at most, their presence was only suspected ante-mortem. Gery[3] described a pedunculated tumor of 850 grams on the pleura of the left lung overlying the heart. This tumor was revealed only at necropsy. Judging from the histological picture shown by the half-tone illustration, it was an undoubted case of single neurofibroma. Because of the varied designations of these tumors it is not possible to state that no other reports of operative removal of such tumors from the pleura exist. A careful search of the literature would lead one to believe that they are of rare occurrence.

CASE.—The patient (N. F.), was a Filipino house servant, thirty-eight years of age, who was admitted to Walter Reed General Hospital, July 31, 1928. Her family and previous histories threw no light on the condition which is the subject of this report.

Present Illness.—For the past year she had noted pains and tenderness in the joints of the extremities, especially the fingers and toes. During this time she felt that she tired easily. She had been troubled with constipation for many years.

Physical examination revealed a small Filipino. Height fifty-seven inches, weight eighty-six pounds. Blood-pressure, systolic 110, diastolic 77. The fingers and toes showed rather marked swelling or clubbing due to increase in size of the phalanges. The knees were somewhat stiff. There was dulness and increased voice sounds over the left lower thorax laterally and posteriorly with lagging of respiratory movements in this area. There was moderate periodontoclasia, but otherwise no important abnormality. Röntgenographic examination showed a tumor in the left lower chest which moved with the diaphragm. (Fig. 1.) A general medical survey failed to indicate the character of the tumor and revealed the patient in good condition for operation.

Phrenicotomy was done August 17, 1928, under local anæsthesia. On August 30, 1928, the tumor was removed under gas-oxygen anæsthesia. Exposure was by an inter-
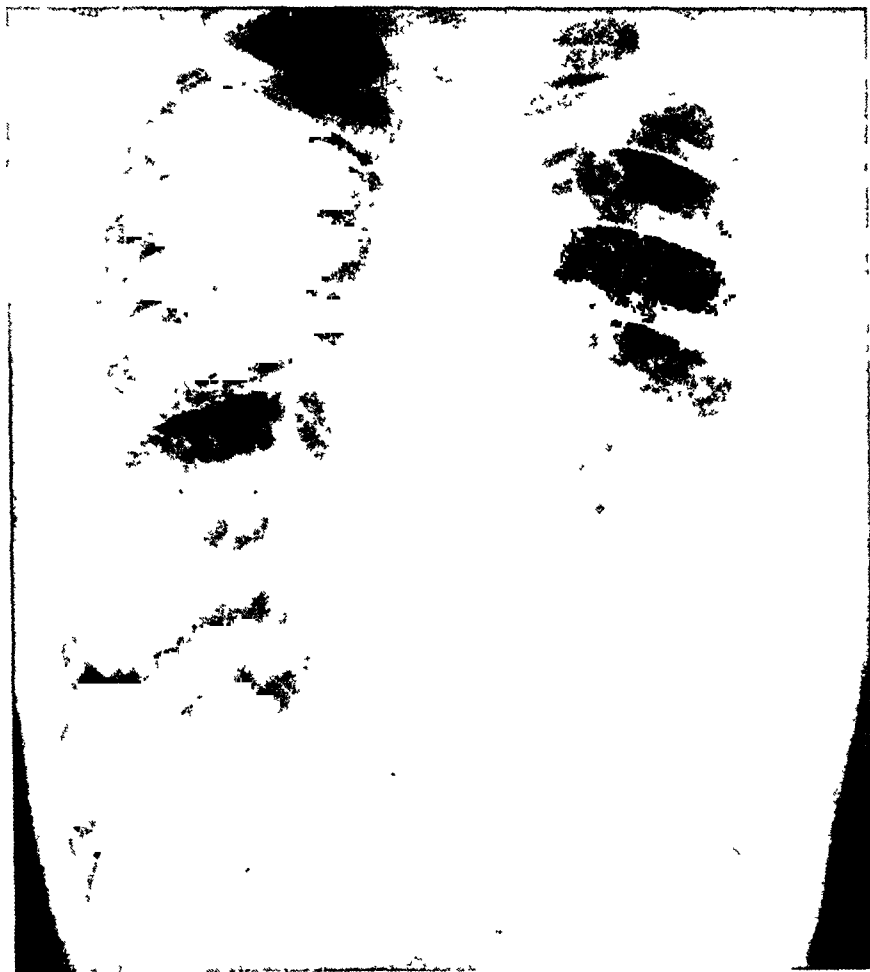
Fig 1.—Rontgenogram of thorax before operation

costal incision in the sixth space, extending from in front of the anterior axillary line to a point well beyond the posterior axillary line. The sixth and seventh ribs were divided both anteriorly and posteriorly and turned upward and downward respectively. The incision was spread by means of a Tuffier retractor sufficiently to expose the tumor which was incapsulated with numerous vessels running in its smooth capsule. This tumor was attached to the pericardium by a broad pedicle five centimetres in diameter and to the lower lobe of the left lung by a smaller pedicle two centimetres in diameter. (Fig. 2.) The pericardial attachment was divided between clamps applied successively as division progressed, thus ensuring complete hemostasis. In dividing the pedicle attached to the lung it was necessary to remove a small portion of lung tissue. The damaged lung was carefully repaired with two layers of interrupted fine chromic gut sutures. After the vessels on the pericardial surface had been ligated there remained

a large raw surface somewhat greater than the diameter of the pedicle. Because of the patient's condition it was not deemed advisable to prolong the operation by efforts to reduce his area in size. Three pericostal sutures of silver wire were first introduced to aid in approximation of pleural and intercostal tissues, which were closed by a continuous suture for the entire length of the incision. This suture was not pulled tight and a free loop was left every third or fourth stitch to facilitate closure. The wire sutures encircling the ribs were tightened and after overinflation of the lungs by means of increased positive pressure on the anæsthesia apparatus the pleural suture was drawn tight. The skin was closed with interrupted sutures of silkworm gut without drainage.

There was moderate post-operative shock, relatively easily controlled. The patient ran a temperature of moderate degree for about a week, following which convalescence

PERINEURAL FIBROMA
ATTACHED TO PERICARDIUM AND LUNG
OVER COURSE OF THE PHRENIC NERVE
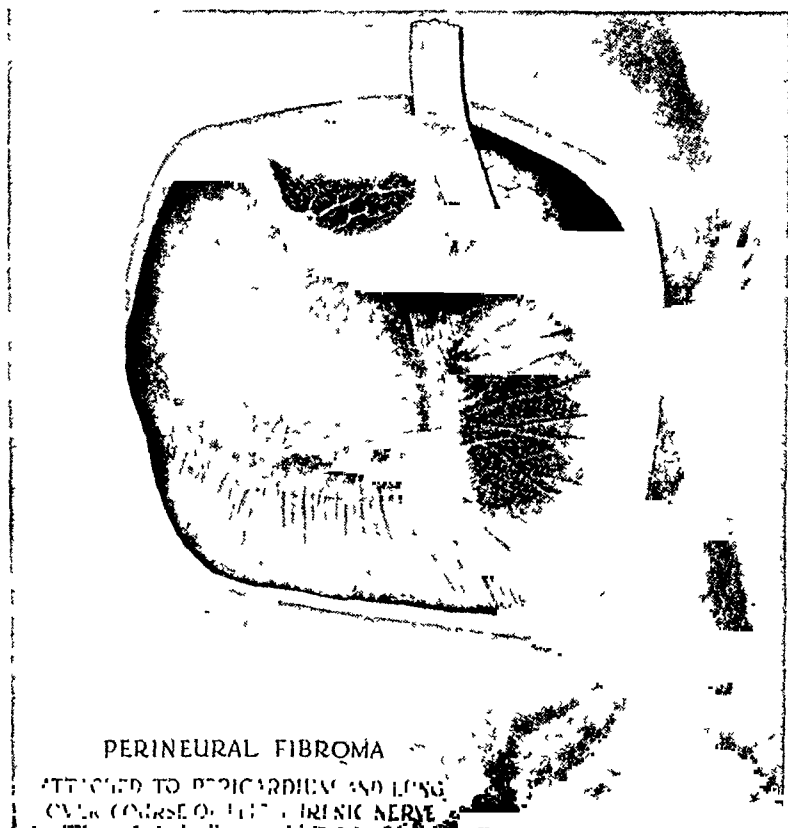
Fig 2 —Drawing showing the tumor and its relation to the pericardium and lung

was uneventful. Twenty hours after the operation, 275 cubic centimetres of sero-sanguinous fluid were removed from the chest, and though there was some accumulation after this it did not require removal.

Description of specimen —Army Medical Museum accession 29631. The specimen weighed 660 grams. It was irregularly oval in shape and measured 14 centimetres in its longest diameter, 11 centimetres in breadth and 8 centimetres in thickness from attachment to periphery. (Fig. 3.) At the upper posterior angle of the area of attachment a small piece of lung tissue was adherent. Vessels radiated around the tumor in the capsule from the area of attachment and were small arteries and larger veins. The capsule was smooth and covered with pleural endothelium. On section the cut surface showed irregular mottling near the capsule of a reddish-gray, translucent tissue with firmer streaks of paler tissue. There appeared to be three masses of tumor—one

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above, one below, and a smaller one adjacent to the area of attachment. The main tumor mass showed pale opaque yellow areas surrounded by more dense tissue, the centres of some of these opaque areas being necrotic. There was some blood-filled vessels scattered throughout the tissue. (Fig. 4.)

Microscopical examination.—Sections taken from the pedicle area showed a rather cellular tissue composed of elongated cells of the fibroblast type. Between these is a relatively dense, collagenous matrix. The capsule was pierced by vessels and there were extensions of the tumor cells along these vessels to beyond the capsule, but the vessels themselves appeared independent of the tumor tissue. For a few millimetres beneath the capsule in all sections, the cells were relatively close together, but as the distance from the blood supply increased, collagen became more abundant. In numerous areas the cells were arranged in palisade formation around fibrillar centres, and occasionally these palisade formations surrounded small vessels. (Fig. 5.) The greater part of the dense tissue was formed of bundles of collagen fibrils in more or less parallel arrangement with nuclei between them. This arrangement suggested the picture in longitudinal sections of a nerve trunk, except that there were nerve fibres only in sections from the area of attachment. (Fig. 6.) Here a few medulated fibres were found but elsewhere the collagen masses appeared to to be free from actual nerve elements. Mitotic figures were not seen, and while the tumor in some areas particularly near its attachment were very cellular, it did not have the picture of sarcoma.

FIG 3 —The tumor, showing area of attachment.

The histological structure is that of a neurofibroma, the type cell producing collagen as does the ordinary fibroblast, while the arrangement is that of the cells surrounding the fibres and bundles of nerves in a nerve trunk.

This patient presented one condition, aside from the tumor, which was of interest: namely, the swelling or clubbing of the fingers and the stiffness at the knee-joint. The condition of the fingers was that seen in so-called pulmonary osteo-arthropathy and presumably it was secondary to the changes produced as a result of the location of this tumor in the chest. There was no indication of cardiac lesion. Brooks and Lehman[1, 4, 5] have described bone lesions in the neurofibromatosis of Recklinghausen, but in their cases they

believed that invasions of the bone by the tumor tissue accounted for the major changes in long and flat bones. They do not record the condi-
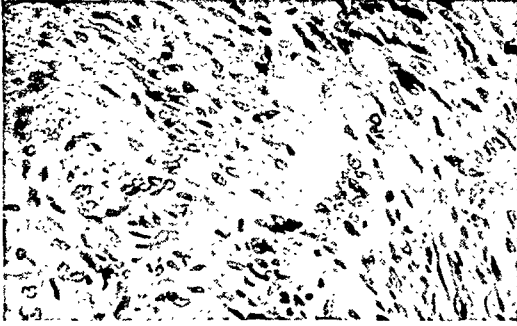
FIG. 4.—Photomicrograph showing palisading of nuclei about bundles of fine fibrils.
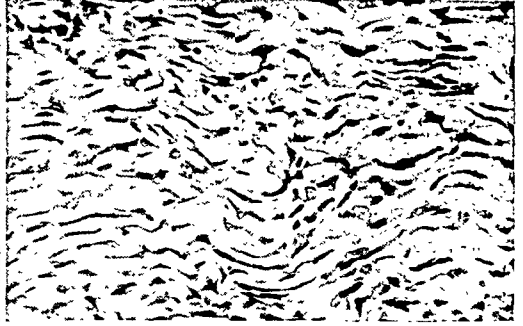
FIG. 5.—Photomicrograph showing parallel arrangement of bundles of collagen fibrils, simulating nerve structure.

tion found in this case, which presented none of the physical signs of Recklinghausen's neurofibromatosis.

In this connection it is interesting to note that the pain and tenderness
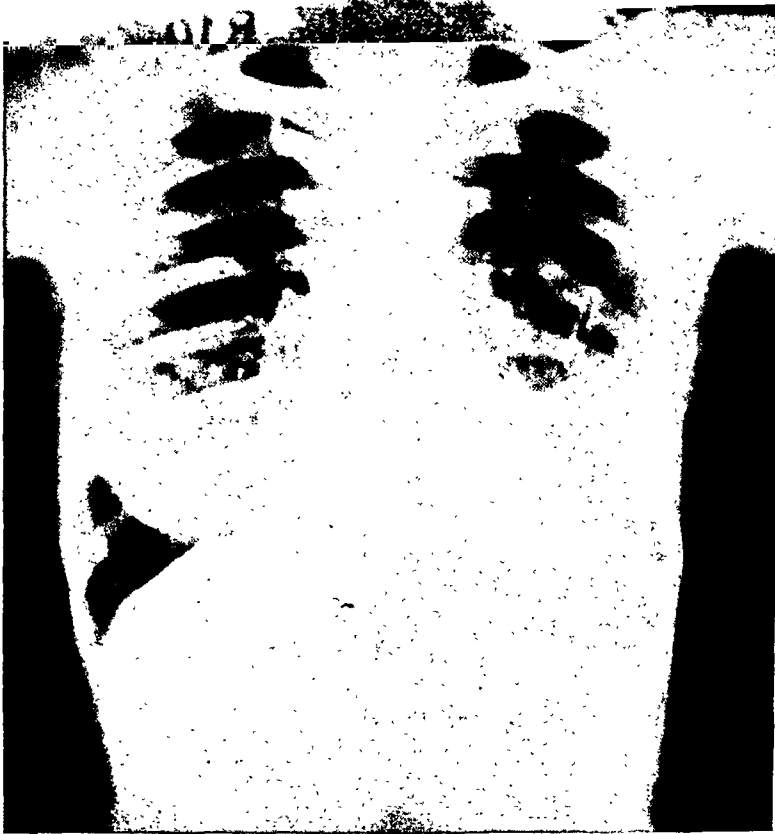
FIG. 6.—Röntgenogram of thorax eighteen months after operation.

of the joints of the fingers and toes and the stiffness of knees complained of prior to operation have completely disappeared, and the osteo-arthropathy has shown much improvement. This patient is at present in good health and

working at her previous occupation of house servant, one and one-half years after the removal of the tumor, and X-ray examination shows no evidence of the return of the growth.

SUMMARY

A case is recorded of single neurofibroma arising on the pericardial pleura over the course of the left phrenic nerve with successful operative removal. The case also presented the bone changes which have been designated as pulmonary osteo-arthropathy.

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DISCUSSION: DR. HOWARD LILIENTHAL, of New York, reported the details of a gigantic tumor of the subpleural tissues which he removed last December. This tumor very much resembled the one that Doctor Keller had shown here, and was of about the same size. It was discovered quite by accident. The woman had been operated upon for a pelvic condition by Doctor Heyd of New York who noted at that time a tremendous incurvation of the nails and clubbing of the fingers. X-ray films disclosed almost the exact picture presented in Doctor Keller's case. Doctor Lilienthal operated and found that this particular tumor sprang, as most of these gigantic tumors of the pleura do, from the edge of the pulmonary lobe, but it looked like a lung tumor. In removing it he was obliged to sacrifice a little of the upper lobe of the lung. There was a very large adhesion to the pericardium which was cut through without difficulty, and another adhesion to the anterior chest wall. The patient is now well.

He had also observed and operated upon a gigantic tumor of a similar type which was referred to him by the courtesy of Doctor Woolsey who had operated upon the patient and had taken out a specimen the size of a tennis ball. One pathologist reported the case as one of pure fibroma and another reported it as a fibrosarcoma of extremely low malignancy. The specimen examined by Doctor Klemperer of Mount Sinai Hospital, New York, was pronounced positively non-malignant. The man came back five years later with a softened swollen area near the site of the tumor which was still present. Of course it was impossible to remove this tumor. All he could do was to shell out part of it, and that part was pronounced to be malignant. It had changed its character completely. It was a lesson in prognosis. This patient now has a metastasis in his contralateral lung. In the

first case, the giant tumor of the pleura with adhesion to the pericardium, he was able to remove the entire neoplasm in one piece.

In addition to these two cases he had removed a ganglioneuroma of the first thoracic ganglion in a child. The case has been reported in his book written some years ago ("Thoracic Surgery." Saunders, 1925, pp. 286–290) and the patient has been followed up to the present time, which is now nearly six years without recurrence.

To those of you who are interested in the subject, I will say that Doctor Klemperer and Doctor Rabin have handed in a paper to the American Society of Bacteriologists and Pathologists at their last meeting, which will be published in their transactions. Doctor Rabin went through the literature very, very thoroughly and found only a small number of this type of tumor, that is the gigantic sarcomata of the pleura. I think only two of the cases had been reported as having been operated upon. Most of these patients die on account of the enormous size to which these tumors grow and which produces fatal circulatory changes. For the past few years he had pleaded for exploratory operation in cases of thoracic tumor to me.

DR. MILES F. PORTER, of Ft. Wayne, Ind., recited the history of a woman fifty-four. years of age who came to him with a tumor in the region of the sciatic nerve a little above the middle, her chief complaint being peculiar sensations along the distribution of the sciatic nerve below the location of the tumor. When first seen, the tumor was about six inches in length, about four inches in thickness, and was oval in outline. He removed the tumor. It was pronounced sarcoma by the pathologists of the hospital. He found the tumor close to the nerve, but did not think it necessary to invade the nerve in order to make a decently thorough removal.

In a few months she came back with a tumor in the same locality. He again excised the tumor without invading the nerve. The third time she came back. Again he excised the tumor without invading the nerve. Again she came back and this time in order to make what he deemed a reasonably thorough operation, he removed about five inches of the sciatic nerve, dividing the nerve at either end, removing the tumor with the nerve.

All of these tumors were examined by two different pathologists, but in the same laboratory, and they were all pronounced fibrosarcomas.

Five years after the fourth operation a letter was received by him from the patient announcing that the day she was writing the letter was the fifth anniversary of the fourth removal of that tumor and she wanted him to know that she was alive, well, and able to do her own housework.

OSTEOCHONDROMATOSIS

By Emmet Rixford, M.D.

of San Francisco, Cal.

FROM THE SURGICAL SERVICE OF STANFORD UNIVERSITY

Osteochondromatosis is not merely a somewhat rare disease, but is otherwise an interesting affection. It is limited to the synovial membrane of joints, affecting other joint elements and neighboring structures simply by pressure and mechanical interference with function. Bunne (Deut. Med. Woch, 55, No. 27), succeeded in finding only eighty cases in the literature previously to July, 1929. Of these only one was in the hip, but Bunne himself reported two of the hip, both in men over sixty. To these eighty-two cases may be added one of the knee herewith reported, and a number of others unreported of which I have learned by personal communication. But the affection is probably much less rare than indicated by these figures. The affection is generally monarticular, for in only three of eighty-five cases were two joints affected. Of the etiology nothing is known. Lexer and others suggested that it was a congenital affair dating from the period of formation of the joint; there having occurred some sort of interference with the differentiation of the mesenchyme into cartilage and synovial membrane, the late discovery of the abnormal masses of cartilage being accounted for by the extreme slowness of their development. But it is difficult to reconcile this theory with the fact that the pockets and folds of the synovial membrane seem to be sites of predilection and the fact that the trouble is most often discovered in later middle life, too late to make even so slowly growing masses probably congenital although be it said a few cases have given history of trouble with the affected joint beginning in youth. Trauma seems unlikely —at least one can say with certainty that if the disease is to be attributed to a single trauma as is done by many of the victims, the extreme chronicity of the affection and its slow development would exclude any trauma alleged to have occurred shortly before the discovery of the swelling. But chronic irritation of the synovial membrane as from repeated slight traumata in some pernicious habit of striking or bumping the knee repeatedly as in some occupations, would seem to be more promising as an hypothesis.

Boehm (Deut. Ztsch. f. Chir., 212, 1928), discusses at length the four principal theories of the cause of osteochondromatosis, viz., infectious, traumatic, embryonic and neoplastic. He concludes that the disease is of the nature of a non-malignant tumor but that trauma cannot be excluded as a cause. As to the particular points of origin of the process, there are almost as many different observations as authors who have studied the matter.

Examples of change from one form of mesoblastic tissue into another are not unknown and from various causes, e.g., the development of bone in muscle in diffuse myositis ossificans, in which there is no suggestion of

trauma but in which the blood calcium content is abnormally high; the development of bone in a vein long obliterated by thrombosis; the development of a bursa with wall very like synovial membrane under the influence of continued movement in pseudarthrosis and in arthroplasty.

Osteochondromatosis consists essentially of the development of cartilaginous masses on the inner surface of the synovial membrane. These differ in size and form in the same case and in different cases. In most cases they consist of great numbers of cartilaginous buds varying from microscopic size to individual chondromata several centimetres in diameter, commonly with small pedicle and hence often broken off becoming loose bodies in the joint. They seem to be entirely independent of the joint cartilage proper which even in exaggerated cases remains apparently normal. Reichert (Deut. Ztsch. f. Chir., 1900), reported a case in which the new-grown cartilage took the form of large flat plates. There is a marked tendency to *the development of bone in the centres of the cartilaginous buds or papillæ* as well as unorganized calcification. Since the advent of the Röntgen-ray this fact makes the diagnosis relatively simple though previously difficult. The X-ray picture, showing, as it does, multiple points or masses of calcification in and around the joint but detached from the bones which latter are essentially normal in outline, can hardly be confounded with that of any other lesion. There often is demineralization of the bones of the limb such as is common in non-use, also evidence of pressure effect, but the picture as a whole is very different from those of ossifying sarcoma, budding exostosis, arthritis deformans, excessive callus following fracture, myositis ossificans, etc. It is a curious thing that muscles, aponeuroses and fascias about the joint may be penetrated or rather traversed by the cartilaginous masses and yet there is no true infiltration as in malignant tumors, the collective masses remaining encapsulated. It is as though the catilaginous masses backed out through areas of least resistance carrying the expanded synovial membrane before them. The skin seems not to have been penetrated in any case thus far reported. Extension is purely by continuity; metastasis has not been observed. There is no abnormal amount of fluid in the joints as in neuropathic arthropathy though the surfaces of the cartilaginous papillæ are moist with normal-appearing synovial fluid, nor is there comparable absorption of the bones giving rise to abnormal mobility. Histological examination shows the abnormal masses to consist of apparently normal cartilage, perhaps somewhat more cellular, with central calcification and bone formation.

Clinically, the cases differ chiefly in phenomena which might be expected to vary with the duration of the process and the size and location of the cartilaginous masses—swelling, limitation of motion, rarely spontaneous pain, possibly some pain in attempting to exceed certain limits of motion, sharp pain, to be sure, when one of the loose bodies, especially if extensively calcified, is caught between the bones of the joint—in the hip there has been reported pain suggestive of sciatica—limping, if in knee, hip or ankle, atrophy of muscles, sometimes contractures, but above all and most charac-

teristic, the negative symptom of surprisingly little interference with function in view of the size of the cartilaginous masses.

The following case is typical.

R. H. M., aged sixty-nine, an Englishman, an old sailor, fond of the out-of-doors, remembered having strained his right knee seven years ago while tramping in the Sierra Nevada with a pack on his back. Shortly thereafter the knee became swollen and the swelling persisted and slowly increased, with the formation of great masses of firm tissue which he likened to bags of gravel. He had never been disabled, said that the knee would get smaller when he exercised—in fact, he had taken several hard mountain
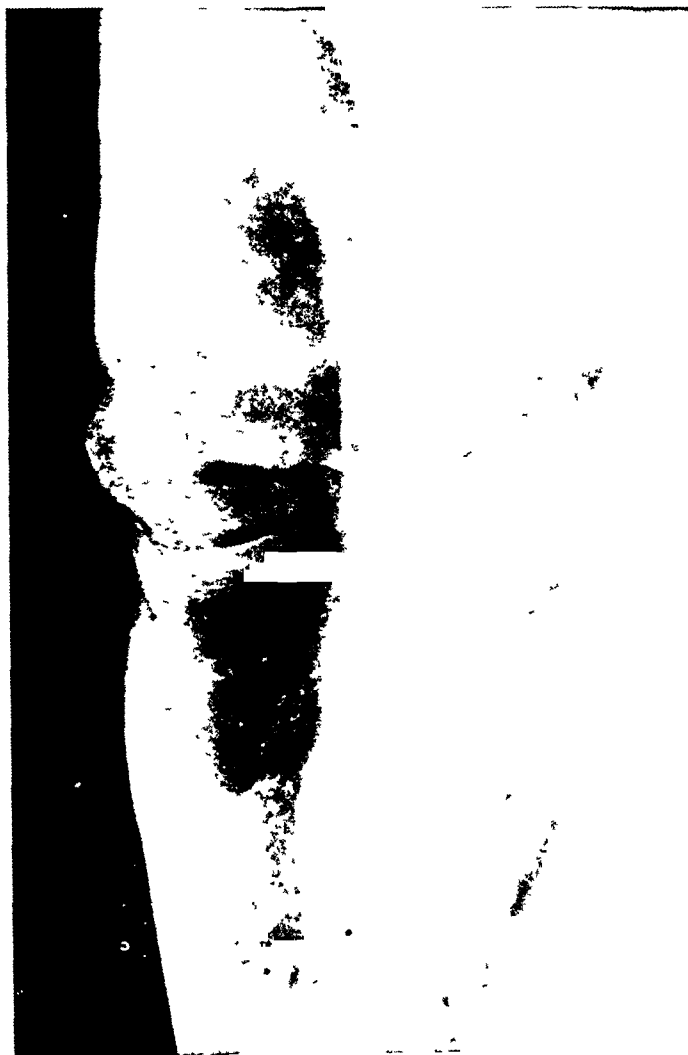
FIG. 1.—Relative size of knees before operation.

trips on foot since the knee became swollen. There was almost no pain but a good deal of stiffness and discomfort in getting about in the morning, the trouble disappearing as the day wore on, the whole picture, however, slowly progressive.

Examination, July 16, 1929.—A short stocky man not overweight (136 pounds) right knee enormously swollen (Fig. 1) with great "bags" of firm material very suggestive of gravel with grating vibration when touched, the vibration also appreciated by the ear—these masses distending the joint and extending out in various directions, one mass the size of a hen's egg, having perforated the vastus externus muscle and its sheath, lay subcutaneously above the lateral aspect of the joint; others filled the popliteal space obliterating the ham strings and one much larger, of the size and proportions of a fat banana (red variety) extended subcutaneously down the calf for about

fifteen centimetres. Blood Wassermann reaction negative, leucocytes 7,500, 54 per cent. polymorphonuclears, 40 per cent. lymphocytes, urine negative. X-ray films showed normal bone contours, but an infinitude of minute specks, evidently shadows of calcium particles, presenting such a picture as would be given by looking at the Milky Way throught the leg if by some miracle it had become transparent. In stereoscopic examination the bones, normal except for some demineralization, seemed to be suspended in a cloud of minute stars.

Under local anæsthesia the subcutaneous mass on the outer side of the joint was exposed. It was completely encapsulated and when incised was found to communicate widely with the upper part of the joint so that the finger was readily introduced. The diagnosis was evident—histological examination showed merely cartilage with calcification, nothing suggestive of malignancy. It was a question whether to perform resection of the knee as is commonly advised or to dissect out the entire synovial membrane and

FIG. 2.—Interior of joint; patella retracted.   FIG. 3.—Interior of supra-patellar bursa.

make an effort to preserve some motion in the joint. The latter procedure was chosen and carried out as follows:

Through a wide horseshoe incision with concavity above, the patella was sawn through transversely and the muscles and fascias divided in the same line. The entire synovial membrane (Figs. 2 and 3) was found to be involved in the process and was excised, even that on the cruciate ligaments and on the posterior aspect of the joint above the femoral condyles. The bone and joint cartilage proper seemed completely normal. To gain access to the posterior parts of the joint and the bursæ all the ligaments of the joint were cut except the cruciates. The large mass extending down the calf was removed through a second incision. The dissection was not difficult because of the complete encapsulation of the cartilaginous masses, which were therefore easily shelled out (Fig. 4). Some of the intra-articular masses were attached to the synovial membrane by long fibrous threads; many were loose in the joint. The patella was drilled and sutured with silver wire as in transverse fracture—the ligaments, muscles and fascias with fine chromicized catgut, skin with interrupted silk-worm gut. A small

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rubber dam drain was left in the lateral aspect of the joint for twenty-four hours. No splint was applied but the leg laid in slight flexion over a pillow.

Normal wound healing, patient out of bed on crutches on the fifteenth day. No massage or passive motion was prescribed but patient was encouraged to move the knee actively as much as he could. In three months all swelling had disappeared, the knee appeared perfectly normal with perhaps 10° of active flexion. There was not more limp than would be accounted for by the limitation of motion, lateral stability excellent, but by way of caution patient wore a cane when on the street.

Nine months after operation there was almost no limp, extension was normal, active flexion 45°. There was no sign of regrowth of cartilage, but, of course, the patient could not be assured that some small portions of synovial membrane had not been left behind, or minute bits of cartilage by which the process might be continued.

Final histological examination by Dr. W. Ophuls was reported as showing "clusters
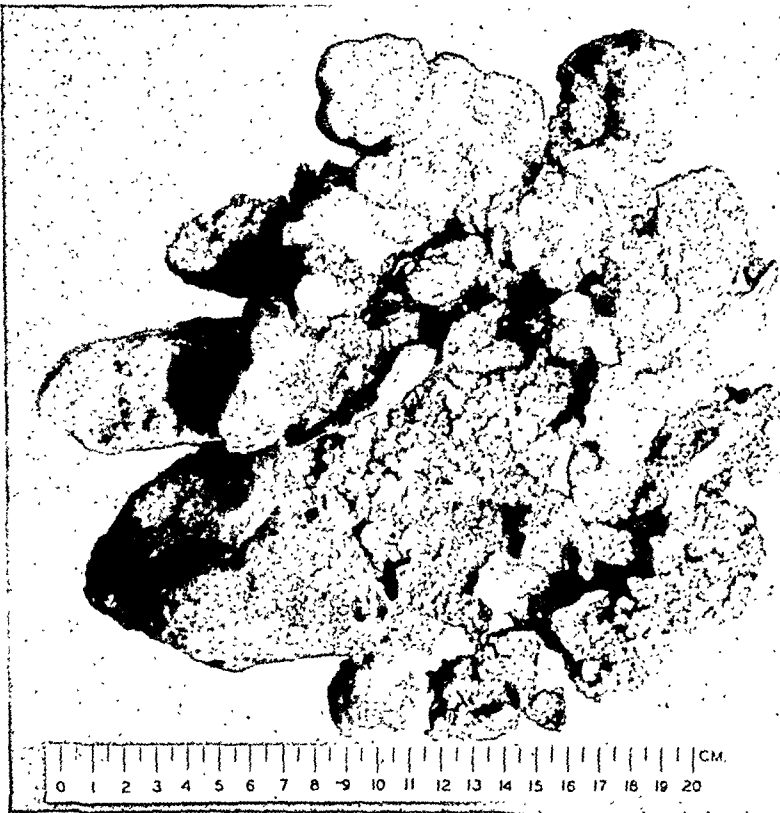
FIG. 4.—Masses of cartilage after removal.

of small pieces of hyaline cartilage which are embedded in fibrous tissue. The cartilage is quite cellular especially at the edges. It is partly calcified and shows signs of beginning ossification."

The cellular character of the cartilage above described and the fibrous tissue accompanying it would seem to speak strongly for an inflammatory origin of the process. The fact that the patient noted the swelling for the first time at the age of over sixty-two speaks against a congenital origin especially since he is something of a sculptor and a good observer of form. Moreover, the fact that the entire synovial surface of the joint was involved further suggests surface irritation as the cause.

DISCUSSION: DR. CHARLES GESCHICKTER, of Baltimore, Md., alluded to the relation of these lesions to certain histogenic processes about the joints, and discussed the mode of extension of this type of cartilaginous tumor. It is not possible to deny a connection between the lesions of osteochon-

dromatosis and normal developmental processes in the tissues, merely on the grounds that they occur most frequently in adults. Nor can it be assumed that because much fibrous tissue is present in the lesion, that this connective tissue is a defensive reaction and that the lesion is therefore inflammatory. As a matter of fact there are fundamental embryonic changes which occur in tissues about the joints, which date back to fœtal life, and which persist in the adult in the regions of the normal joint capsule, the normal synovia and at the points where tendons and ligaments attach periarticularly.

These tissue changes which are identical in character in both the embryo and the adult, and which we believe are related to the lesions of osteochondromatosis concern the differentiation of cartilage and bone from a primitive form of connective tissue. This primitive connective tissue which gives rise to cartilage and which subsequently may ossify if irritated or infected, is present not only at birth and in the normal embryo, but persists throughout life. Köllicker, in 1853, showed that cartilage cells and small cartilaginous masses embedded in connective tissue were part of the normal histology of tendons, such as those that attach at the heel and about the knee joint. By excising bits of tissue from the region of the joint and the neighboring tendons and ligaments, we have confirmed the findings of Köllicker and have found in addition that these cartilaginous masses are not restricted to ligaments and tendons, but may be found also at the point of reflexion of the normal joint capsule and in the region of the synovia. The significance of the cartilage and partially ossified material found in these structures must be attributed to the developmental powers of the connective tissue in which they are embedded. This connective tissue retains its primitive power of forming both cartilage and bone, and its persistence about joints accounts for the chondral and osseous masses found not only in chondromatosis of the knee joint, but also in the so-called calcaneal spurs at the heel associated with chronic gonorrhœal arthritis, and for such lesions as calcified bursitis and the osteophytes of the proliferating form of chronic arthritis. Since the synovial membrane is derived from this same connective tissue, it may be involved by the same type of pathological processes.

The extension of the disease of osteochondromatosis, which usually originates in the synovia, into the neighboring ligaments and tendons is in all probability not a matter of extension, but of a further involvement of an identical type of early connective tissue by the same pathologic process. Such a diffuse involvement has been reported by Doctors Jones and Henderson of the Mayo Clinic in a case in which there was not only osteochondromatosis of the knee joint but cartilaginous exostoses above the knee and about the femur at points of tendinous attachment. It is interesting that the cartilaginous exostoses in this case showed histologically the same type of transition from connective tissue to cartilage to bone that was found in the joint mice within the knee joint. In this particular case the exostoses later gave rise to osteogenic sarcoma. This single case in which osteochondromatosis

of the knee joint, exostosis above the knee and osteogenic sarcoma were all found in the same patient, illustrates very emphatically the close relationship of these various types of new growth to the fundamental transitional processes found in connective tissue and also the close relationship of these various neoplasms to each other. On this basis it can be said that osteochondromatosis is only one of a group of processes that may occur in connective tissue, which retains the power of both cartilage and bone formation. Osteophytes in chronic arthritis, exostoses of bone and even certain types of osteogenic sarcoma may show a similar type of pathology.

The histogenesis of these lesions is easier to trace than their exact etiology. In discussing the etiology of these lesions, he differed from Doctor Rixford in that he believed the location of the growth a more important consideration than the age of the patient. The significance of the location of these lesions within the joint and the occurrence of similar pathologic changes in the immediate vicinity of the joint is that the connective tissue involved by the lesion persists in an undifferentiated form in adults in only such locations. Embryologically, connective tissue which gives rise to cartilage at the site of the future skeleton disappears shortly after the bones have been preformed in cartilage. It is only about joints and periarticularly that strands of this same connective tissue exist for the purpose of taking part in the development of the future joint. Why these strands should continue to function long after the joint structure is complete is not entirely clear. It is also not clear how trauma and infection act in stimulating this undifferentiated tissue to further development. It is nevertheless a fact that both trauma and infection may act later in life to produce true tumors in this tissue and in this respect he agreed with Doctor Rixford that inflammation and injury may be exciting causes. Nevertheless it is important to emphasize that the actual diseased tissue of osteochondromatosis represents an over-stimulation of a normal process and that this peculiar combination of fibrous tissue, cartilage and bone is not restricted to this particular malady.

Dr. Dallas B. Phemister, of Chicago, Ill., said that an unusual feature of Doctor Rixford's case was that so many of the osteocartilaginous loose bodies remained attached. In the cases of multiple bodies that he had seen, the great majority of them have been free in the joint, but the large ones are likely to be attached. The free bodies are nourished by the synovial fluid and increase in size, affording the best example of tissue culture *in vivo* that he met with. There is usually a fibrous peripheral layer which passes over into hyaline cartilage which in turn passes into calcified cartilage. Lamellæ of bone also form which are free of Haversian canals and of bone marrow.

Multiple loose bodies occupying both the anterior and posterior recesses of the joint are best removed through an anterior median incision either splitting or circumventing the patella and through postero-mesial and posterolateral incisions just back of the ham string muscles on either side.

Dr. Ernest A. Codman, of Boston, Mass., said, in regard to the case which Dr. Bloodgood alluded to of a very large osteochondromatous tumor

of the upper end of the humerus, it was not "inadvertently," that he left the chips in the wound. He had disarticulated the joint and excised the tumor to about the mid-humerus, but as the nerves and vessels lay in tunnels in the tumor, chips were necessarily scattered through the tissues. He knew they were there and he cleaned out many of them.

The operation was about fifteen years ago. Many of the chips grew afterward and although they were almost microscopic, they would develop tumors as big as hen's eggs composed of pure cartilage. Some of them even appeared up around the clavicle. These had a myxomatous consistency. After repeatedly removing these small growths, he made a shoulder-girdle amputation. The patient has been well since.

The case illustrates a lesson that osteochondromatous tumors that have bone pedicles should be thoroughly excised rather than have any relation to the particular disease, an instance of which Doctor Rixford had presented.

CANCER OF THE BUCCAL MUCOSA

THE RESULTS OF TREATMENT BY OPERATION AND RADIATION

BY CHANNING C. SIMMONS, M.D.

OF BOSTON, MASS.

IN SEPTEMBER, 1926, I reported a review of the cases of cancer of the tongue, cheek, jaws, palate and tonsils, observed at the Collis P. Huntington Memorial Hospital and at the Massachusetts General Hospital, during the three-year period, 1918–1920.[1] There were 376 cases and the results of treatment by radiation and surgery were studied and reported. These cases were followed for a period of three years from the date of treatment.

The present communication is a study of a similar group of cases observed at the same institutions during the three years, 1921 to 1923, 387 in number, treated by surgery and radiation and followed for not less than five years. The study was made to learn, if possible, what improvement had been made in the results since during this period the technique of radium and X-ray treatment had improved, and the use of larger doses, and of gold and platinum seeds of radium emanation had become general. There were relatively few changes, however, in the surgical treatment, as at this date electro-surgical methods had not been generally adopted.

The author wishes to thank Dr. H. F. Hartwell, of the Massachusetts General Hospital, and Dr. Shields Warren, of the Huntington Hospital, for their assistance in the pathological work and grouping of the cases as to their relative malignancy.

The Committee on Cancer of the American College of Surgeons has adopted an arbitrary time limit of five years to be applied to all cases of cancer before they are to be regarded as a cure, and to conform to this regulation no case is spoken of as a cure unless living and without evidence of the disease five or more years after treatment, and unless the diagnosis was confirmed by microscopic examination.

The groups studied were cancer of the tongue, floor of mouth, cheek, palate, upper jaw, lower jaw and tonsils. Cancer of the lip was excluded as it is a distinct type of cancer much less malignant than the same disease arising in the buccal mucosa, and cancer arising in the antrum was also excluded. All cancers arising from the buccal mucosa have been considered together, however, for although varying somewhat in malignancy according to their situation the tumors are all of the same type and the course of the disease is essentially the same.

The cases may be divided as follows: (see Table I).

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[1] Surgery, Gynecology and Obstetrics, September, 1926.

TABLE I

	Primary No Metastases	Primary Metastases	Recurrent	Totals
Tongue........................	48	89	10	147
Floor of mouth.................	5	15	2	22
Cheek.........................	25	25	6	56
Lower jaw.....................	15	38	4	57
Upper jaw.....................	12	10	4	26
Palate........................	10	12	3	25
Tonsil........................	19	35	0	54
	134	224	29	387

In making this study in the former paper the cards advocated· by the Cancer Committee of the American College of Surgeons were used and their classification adopted; and for comparison this paper has been arranged along the lines of the previous communication. For the benefit of those who are not familiar with the classification adopted by the College of Surgeons, I would say that the cases are divided; first, into two main groups, primary and recurrent; and the primary further divided into those with or without evidence of glandular metastases at the time of their first consultation.

There were 387 cases of cancer of the buccal mucosa admitted to the two institutions during the three-year period, as follows: Collis P. Huntington Memorial Hospital, 336; Massachusetts General Hospital, 26; both institutions, 25.

Etiology.—The etiological factors were the same as in any other similar group. Ninety and seven-tenths per cent. of the cases were males, and 9.3 per cent. females. The average age was fifty-nine, and 82 per cent. of the cases were over fifty years of age. There were two patients under thirty, the youngest being eighteen. This latter patient had a cancer of the hard palate. Eighty per cent. used tobacco in some form. Most of these smoked while many chewed as well.

Leucoplakia was noted as being present in 25 per cent. of the cases, and must be considered as a distinct pre-cancerous lesion. It was associated with syphilis in 70 per cent. of the cases in which it was present. The blood Wassermann was taken in 227 cases and was positive in 47, or 20 per cent.

Data in relation to the teeth were available in many instances. In 167 cases it was definitely stated that the teeth were bad, and seventeen patients dated their first symptoms from a bite or cut from a sharp tooth. Three patients stated the disease was brought on by a cut from a foreign body, and twenty-four believed a poorly fitting false tooth plate was the exciting cause of the cancer. This does not necessarily reflect on the dentist, as many of these patients had not had their plates adjusted for years. In ten of these cases the cancer originated on the alveolar process or palate; in nine it was on the cheek, and in five on the tongue or floor of the mouth.

Duration of disease.—Cancer of the mouth is of relatively rapid growth, and the seriousness of the condition is not appreciated by the patient in its

early stages as it causes little inconvenience and rarely pain. Data on the length of time elapsing from the onset of the disease to the first consultation with the physician were available in 339 cases. Of these, 220 sought advice within one month of the onset, or 64 per cent.; 11.5 per cent. within three months, while 24.5 per cent. delayed for a longer period (see Table II).

TABLE II

Delay First Symptom to First Consultation

	1921–1923	1918–1920
Less than one month (no delay)	64%	40%
One to three months	11.5%	27%
Over four months	24.5%	33%

Comparing these figures with those for the three preceding years, there seems to be considerable improvement, probably due in part to the educational and publicity campaign carried on at that time by the American Society for the Control of Cancer.

Three hundred and sixty-eight of the 387 cases were primary; that is, they had received no treatment prior to their consultation at the hospital. Of these, 68 per cent. presented evidence of glandular metastases when examined, while in 134, or 32 per cent. of the cases the disease was confined to the mouth. The average duration of the primary cases with no evidence of metastases was four months; of those with evidence of metastases, 7.2 months. In other words, other factors being equal the duration has a distinct relation to the extent of the disease and to the prognosis. It will be noted that the duration of the cases cured by operation is six months. In other words the relatively slow-growing type of cancer has the best prognosis (see Table III).

TABLE III

Average Duration Primary Cases

Glands not infected	4 months
Glands infected	7.2 months
Surgical cures	6 months

The advice given by the first physician consulted was ascertained in 340 cases. In 211, or 62 per cent., the correct diagnosis was made and proper treatment advised. Thirty-eight per cent., however, received poor advice and were kept under observation for from two months to one year. It seems fair to assume that the condition was not suspected in these cases. In forty-three the lesion in the mouth was diagnosed as simple ulcer from rough teeth and the patient advised to have the teeth cared for. In fifteen other cases with a positive Wassermann, the diagnosis of syphilis was made and the patient treated for that disease, the possibility of syphilis and cancer being associated, apparently having been overlooked.

Definitions of terms employed.—Cure.—No case is spoken of as a cure unless it is living without evidence of disease five or more years from the date of last treatment, and the diagnosis confirmed microscopically. Patients dying of other causes less than five years after treatment are excluded as inconclusive.

Radical operation.—By this is meant the removal of the local growth and a dissection of the glands of the adjacent side of the neck, removing the sterno-mastoid muscle and the internal jugular vein from the clavicle to the base of the skull together with the contents of the submaxillary triangle. The operation was performed in two stages, with an interval of ten days intervening, the local growth being removed first in most instances. This was done with the knife usually followed by cautery. When excision of the upper or lower jaw was indicated the classical operation was performed, modified to suit the individual case.

Incomplete operation.—Wide local excision of the growth with or without cauterization. This was occasionally followed by implantation of gold seeds of radium emanation. When possible, the local excision was done through the mouth, but, if necessary to obtain a proper exposure, the cheek was split. The incomplete operation was performed in cases which were considered poor surgical risks, in many early cases of cancer of low malignancy and, in a few instances, as a palliative procedure where it was believed possible to remove all the primary growth. These cases were usually accompanied or followed by radium or X-ray treatment.

Radiation treatment.—It has been the policy in both the Massachusetts General and the Huntington Hospitals to treat all early and operable cases of cancer of the mouth surgically, unless operation was contraindicated by the position of the growth or condition of the patient. In most instances radium was employed as gold seeds, containing from one to three millicuries of emanation, introduced about the base of the tumor and allowed to remain *in situ*. The actual method of application of these seeds varied. In certain cases they were introduced in the out-patient department, but in most instances the patient was admitted to the hospital and the treatment given under a local or general anæsthetic. The latter method is much to be preferred and is now being generally adopted. From three to twelve seeds were employed, depending on the size and position of the tumor. Radium was not used when the growth was close to bone on account of the resulting osteomyelitis and severe pain following treatment. Surface applications of radium either as bare tubes or with silver screening were used in certain cases. The glandular areas of the neck were treated by X-ray in preference to radium, both the so-called high voltage and the ordinary treatment being used. As many patients did not report regularly it was found necessary, in drawing conclusions, to judge each case separately and decide arbitrarily whether they had received sufficient or insufficient radiation to accomplish the desired result.

RESULTS OF OPERATIVE TREATMENT

Of the 134 primary cases without evidence of metastases, fifty-four were treated surgically, without operative mortality. Five of these died of other diseases without recurrence less than five years from the date of operation, and have been excluded as inconclusive, and we have been unable to trace two cases for more than three years. There are, therefore, forty-seven cases avail-

able for study of the end-result. A radical two-stage operation was performed on seven, and an incomplete operation on forty.

The results approximate those reported previously. Forty per cent. of the cases were living without evidence of disease at the end of five years (see Table IV).

TABLE IV

Results of Operative Treatment Primary Cases Without Evidence of Metastases (47 Cases)

	Cases	Five-year Cures	Per Cent. Cures 1921–1923	Per Cent. Cures 1918–1920
Tongue	23	8	34	26
Floor	3	1	33	25
Cheek	7	2	29	66
Upper jaw	5	4	80	50
Lower jaw	7	2	29	43
Tonsil	1	1	100	0
Palate	1	1	100	–
Totals	47	19	40	34.7
Cures following radical operations			33	35
Cures following incomplete operations			42	34
Operative mortality			0%	2%

There is a slightly larger proportion of cures of cancer of the tongue with a smaller percentage of cures in cancer of the cheek and lower jaw. The one case of cancer of the palate and cancer of the tonsil operated upon were cured, but in both instances these were very early tumors.

It will be noted that there is a larger percentage of cures following incomplete operation than following radical operation. This is probably to be accounted for by the fact that in cases of very early cancer or cancer of the papillary type, the most favorable causes for cure, local excision only was done.

Twenty-eight cases that showed evidence of metastases were subjected to surgical operation. In ten a surgical cure was attempted with an operative mortality of one case (10 per cent.). Of the remaining nine, one has not been traced and is excluded, and three are living without evidence of disease (33 per cent. of the operative cures). The presence of cancer in the glands was confirmed by the microscope in all these cases, and the three cures were all of a relatively low grade of malignancy.

Eighteen cases showed clinical evidence of glandular metastases and an incomplete operation was done as a palliative measure, combined in some instances with the implantation of radium seeds. There was one post-operative death, and one case has not been traced. The remaining sixteen cases are dead of the disease, as was to be expected, although in three there was no local recurrence before death and, I believe, in most instances, life was prolonged and made more comfortable by the operation. Both of the operative deaths followed excision of the lower jaw (see Table V).

Prophylactic post-operative radiation.—The number of cases is insufficient to allow conclusions to be drawn as to the value of prophylactic post-operative

TABLE V

Results of Operations on Primary Cases with Evidence of Metastases

	Cases	Operative deaths	Untraced	Cures	
Radical operations..........	10	1	1	3	33 per cent.
Palliative operations..........	18	1	1	0	0 per cent.

X-ray. Of the radical operations, five cases received post-operative X-ray treatment, of which two are living and three are dead; while seven cases received no X-ray treatment, of which three are living and four are dead. Of the cases in which there was no clinical evidence of metastases and on which an incomplete operation was performed, eighteen received prophylactic X-ray to the glandular areas of the neck and only one of these is living. Of the twenty-four cases in this group who received no X-ray treatment, sixteen are living. I do not believe that it is justifiable to draw any conclusions from these cases, as it is probable that the more extensive ones only were referred for post-operative X-ray treatment, but it would appear from studying the entire group that prophylactic post-operative X-ray treatment had little effect in preventing or controlling the glandular recurrence.

RESULTS OF RADIATION TREATMENT

It is more difficult to tabulate the cases treated by radiation than those treated surgically. I have applied the same rules as were enforced in analyzing the surgical cases; namely, no patient is considered cured unless the diagnosis was confirmed by pathological examination and he is living without disease five years after the last treatment.

Primary cases with no evidence of metastases.—There were forty-five cases in this group who received sufficient radiation in the form of radium to the local growth. About one half of these cases received X-ray treatment to the glandular areas of the neck as well. As the numbers in these two groups are small and there is no appreciable difference in the figures they are considered together.

Of the forty-five cases available for study, nine have been excluded, as the patient either died of other disease within the time limit or, if living, no pathological report was available. Of the remaining thirty-six, three, or 8½ per cent., are to be regarded as cures. These three cases were: one of carcinoma of the cheek, one of carcinoma of palate, both papillary in character and of low malignancy, and a third of carcinoma of the tonsil, which, although papillary in character, was graded pathologically as of high malignancy. This 8½ per cent. of five-year cures following radiation treatment is to be compared with the 40 per cent. of cures of cases in the same clinical group following surgical operation. There is one other case of cure following radiation treatment, that of a small local recurrence following operation.

In studying these cases treated with radium, individually, the results at first glance seem better than those reported. In five of the cases the patient

died of metastases in the glands within three years from the time of treatment, but the local growth had been destroyed by radium and did not recur within this time; in other words, the radium had probably done to the local growth all that could be expected. In six other cases spoken of as cures in the records, and in which the local growth was apparently destroyed, the diagnosis was not confirmed by pathological examination and there is a definite question as to whether cancer was present or whether the growth was a papilloma or leucoplakia.

Primary cases with metastases clinically in the glands.—There were 138 cases in this group. Twenty-three were not traced, four died of intercurrent disease shortly after treatment and are excluded, and the remainder, 111, died of cancer. There were no cures. This may be compared with the thirty-three per cent. of cures in a similar group treated surgically. It is admitted that the cases submitted to surgery, although in a similar group, were possibly more favorable, but the fact remains that there were no cures following radiation treatment. In analyzing the cases further it is found that there were six cases in which the local growth had been apparently destroyed. Of these six, two died of intercurrent disease within two years of the time of treatment, two died of glandular metastases, although the local growth was eradicated, and two others are living at the present time but the diagnosis was not confirmed by pathological examination and is questionable (see Table VI).

TABLE VI

Radiation Treatment

Primary cases—glands not malignant clinically
    Cases   36
    Cures   3 (8½ per cent.)

Primary cases—glands clinically cancerous
    Cases   111
    Cures   0

Local recurrence following radical operation.—There were three cases in this group treated with radium: one has been lost track of and the other two are both living; one, however, has to be excluded as there was no pathological examination of the tissues and the diagnosis is questionable, as the indurated area treated was probably only scar tissue, while the other, a case of carcinoma of the tongue, should be regarded as a cure.

Prolongation of life by treatment.—There is no question but that in cases in which a cure was not effected by either surgery or radiation the cases were benefited by treatment and life considerably prolonged. This held true in all the groups. The prolongation of life was somewhat greater following surgical treatment than that following radiation, although the operative mortality (2 per cent.) must be taken into account (see Table VIII).

Reoccurrence.—In a previous article, I mentioned certain cases in which the buccal mucosa appeared to have a predilection to undergo malignant

TABLE VII

Prolongation of Life by Treatment—Cases Dying of Disease

	Average length of life
Primary cases—glands not malignant	
Following operation	17 months
Following radiation	12 months
No treatment	6 months
Primary cases—glands cancerous	
Following operation	14 months
Following radiation	10.6 months
No treatment	5 months

changes, and although one cancer might be cured, a second might form in a different part of the mouth and have no relation to the primary growth. This is more apt to occur when there is leucoplakia or in a syphilitic tongue. There were five cases in this series which may be termed cases of reoccurrence; three of these patients had syphilis and leucoplakia. In three the second cancer did not develop until six years after the first had been removed, and in none of these was there any evidence of recurrence of the primary growth. Three of these cases were cancer of the tongue. The history of two of these cases is instructive. In one, a cancer at the foot of the anterior pillar of the fauces was removed in 1921. Three years later a cancer developed in a similar situation on the other side and the patient died six months later of cancer of the lower end of the œsophagus. A second case was operated upon in 1908 for cancer of the lip. In 1920, a cancer of the tongue was removed surgically, and in 1927 he developed a cancer of the other side of the tongue from which he eventually died. The histories of the other three cases are somewhat similar to those cited.

Pathology.—At the present time it is generally considered that, other things being equal, the degree of malignancy, as determined by microscopic examination, is the most important factor in determining the prognosis.

A study of the pathological material of the cases was made in order to ascertain the relation between the degree of malignancy and the prognosis in this series of cases but, unfortunately, a specimen was available in relatively few of the cases treated by radiation. Four degrees of malignancy were recognized as suggested by Broders, and the cases were grouped in a similar manner to those reported in the previous communication. The criteria determining the grade of malignancy is shown in Table VIII.

TABLE VIII

Criteria for Pathological Grouping

1. The amount of differentiation of the cells and keratinization
2. The irregularity in size and shape of the nuclei
3. The tendency to deep infiltration
4. The number of mitotic figures

The specimens were reviewed, arranged in four pathological groups, and the results following surgical treatment are shown in Table IX.

TABLE IX

Results of Operation—Pathological Grouping

	Cases	Cures	Per Cent. Cures
Group 1	13	8	62
Group 2	17	8	45
Group 3	7	1	14
Group 4	4	0	0

These results are similar to those previously reported and confirm those of other observers working with cancer in other situations. How this should effect the treatment of a given case is still somewhat problematical. In general it may be said that if the tumor is small and of low malignancy a local excision without glandular dissection should effect a cure. If the tumor is of moderate size and of low malignancy the radical two-stage operation may be done with some hope of cure. If the tumor is small and of high malignancy, the radical two-stage operation should be performed with very wide removal of the growth, although the prognosis is much worse than that of a larger tumor of a lower degree of malignancy. If, however, the tumor is of moderate size and of high malignancy, local excision or radiation treatment only is permissible, as it is apparently impossible to obtain a cure in this type by surgical operation.

In Table X the results are shown in a manner somewhat different from that in Table IX.

TABLE X

Results of Operation—Pathological Grouping
Incomplete operations

	Cases	Cures	Per Cent. Cures
Group 1	11	5	46
Group 2	12	6	50
Group 3	6	1	16
Group 4	3	0	0

Radical operations

	Cases	Cures	Per Cent. Cures
Group 1	2	2	100
Group 2	6	3	50
Group 3	1	0	0
Group 4	1	0	0

Specimens were available for review and grouping in only eleven cases, treated by radiation, in which the disease was confined in the mouth. There were two cures, one in a case of low malignancy and the other in a case of high malignancy (see Table XI).

TABLE XI

Results of Radiation Treatment—Pathological Grouping
No clinical Metastases

	Cases	Cures	Per Cent.
Group 1	3	1	33
Group 2	2	0	0
Group 3	3	0	0
Group 4	3	1	33

Specimens were reviewed from twenty-eight other cases treated by radiation in which there was clinical evidence of metastases, but there were no cures. The majority of these cases were of relatively high malignancy (see Table XII).

TABLE XII

Results of Radiation Treatment—Pathological Grouping
Metastases present clinically

	Cases	Cures	Per Cent.
Group 1..	3	0	0
Group 2..	6	0	0
Group 3..	8	0	0
Group 4..	8	0	0

The number of cases in these groups treated by radiation is so small I do not feel justified in drawing conclusions from them.

SUMMARY

1. The results of treatment of carcinoma of the mouth by surgery and radiation at the Collis P. Huntington and Massachusetts General Hospitals for the years 1921–1923 were similar to those obtained in the three preceding years, although the results following radiation treatment were somewhat better, probably due to improved technic.

2. In primary cases without clinical evidence of metastases, surgical treatment offers 40 per cent. chance of a five-year cure as against 8½ per cent. by radiation treatment.

3. In primary cases with clinical evidence of metastases radiation treatment offers no chance of permanent cure, and operative treatment 30 per cent. These figures are hardly fair, however, as only the most favorable cases were submitted to surgical treatment. On the other hand, no cases were cured by radiation.

4. Post-operative prophylactic X-ray treatment had no effect in preventing recurrence.

5. Of the primary cases dying of recurrence, life was prolonged by treatment but life is longer following surgical treatment than radiation treatment.

6. In the recurrent cases dying of disease and in inoperable cases, life is distinctly prolonged by radiation treatment.

7. The patients consulted a physician somewhat earlier and the diagnosis was made more promptly than in the preceding group.

8. Other factors being equal, the prognosis depends on the degree of malignancy of the tumor as determined on microscopic examination.

9. The mucous membrane of the mouth in certain individuals seems to be prone to undergo malignant changes, and multiple cancer is not uncommon.

DISCUSSION: DR. VILRAY P. BLAIR, of St. Louis, Mo., said that since two years ago, when he reported his own cases of mouth and lip carcinoma, he had added to that 160 cases. In all things, his observations agree compara-

tively with Doctor Simmons'. He had not seen any improvement in the class of cases sent in for operation. Possibly this may mean that the better cases are being held back and he was getting the worst end of it. That is probably the explanation of that.

The most important point brought out by Doctor Simmons is that idea of emphasizing the period of relief given to the patient by proper treatment rather than cure. If we confine our treatment to cases that promise a cure, we will not help many, but dwelling on the theory that this is probably the most important period of a producing man's life, unless he is very old, two or three or four years added to that man's life adds that much to his most productive period. This thought gives much more enthusiasm about treating cancer of the mouth.

Dismissing the idea of confining our attentions to only curable cases, we are seeing very encouraging results in the use of the radium emanations on the tongue and floor of the mouth. Our operative mortality remains very high because we undertake to operate on most extensive cases on the theory that there is a 100 per cent. death rate if they are allowed to go on, and every comfortable year added is a year of useful life added. Whether we like it or not, we are being driven into treating extensive cancers on the inside of the mouth more and more with radium emanations because the patients are less willing to stand for mutilating operations, especially operations on the tongue.

This point comes up: with our high operative mortality, even though we probably will give those people a longer relief if they survive operation, he wondered if the shorter relief that comes from radium with practically no death rate is not going to be a strong argument for the use of radium, especially in the grade four cases.

The point Doctor Simmons brought out about the development of new cancers in various areas is of great importance and explains more recurrences in well-operated cases than the simple continuation of the original growth. It has been his observation that very few mouth cancers of high grade will live beyond ten years, and that almost all of them that have survived the immediate post-operative period have died as a result of a growth developing in some other part of the mouth or in some other part of the body. These might or might not be considered metastatic but they are not part of the original growth.

DR. WILLIAM B. COLEY, of New York, remarked that in cancer of the mucous membrane one has to choose the method of treatment largely by the individual case. At present he believed most cases can be treated best either by radium or by radium combined with surgery.

He had had two cases of cancer of the tongue that might well be recorded in connection with Doctor Simmons' paper. The first one, in which the disease involved the tongue, the floor of the mouth, and the glands of neck, came under his observation twenty-seven years ago. For this he did a two-stage operation. (1) He made a Y-shape incision, removing the submental

glands and all the muscles of the floor of the mouth, following this by a tracheotomy. (2) Ten days later, after packing the pharynx with gauze, he removed the anterior and greater portion of the tongue, cutting the fraenum in order to mobilize the stump. The patient made a good recovery, and was able to talk sufficiently well to earn his living as an insurance agent. Seventeen years later he returned to the Memorial Hospital with a small epithelioma of the nose, which was cured by radiation. He died about a year ago of nephritis, without having had any return of the former trouble. It was then about twenty-six years since the operation had been performed. The microscopical diagnosis of epidermoid carcinoma with involvement of the glands had been confirmed by Doctor Ewing.

The second case was a carcinoma situated in the left side of the tongue about one inch from the tip. He removed one-half of the tongue but, as there were no glands palpable, no dissection of the neck was performed. He advised the patient to take a course of toxin treatment (erysipelas and B. prodigiosus) as a prophylactic. He was extremely nervous and after a few doses, he refused to take any more. About six months later he again presented himself with a nodule the size of a hickory nut in the upper cervical region on the left side. This was removed, and Doctor Ewing pronounced it an epidermoid carcinoma. No dissection of the neck was made. The patient was immediately put upon toxin treatment (erysipelas and bacillus prodigiosus) which was kept up for nearly six months with occasional intervals of rest. He remained well for more than thirteen years, when he returned with a small nodule in the centre of the scar directly opposite a sharp-edged tooth. The implantation of gold seeds caused apparent disappearance of the tumor within a few weeks. About two months later the nodule reappeared; it was indurated and typically carcinomatous. An extensive operation with a cautery knife was made which was followed two or three days later, on account of profuse hæmorrhage, by ligation of the external carotid artery . The patient was given another course of toxin treatment as a prophylactic. He has remained well up to the present time, slightly over three years since the last operation.

This makes two cases of carcinoma of the tongue that have remained well for twenty-five and sixteen years, respectively, since the operation. Inasmuch as Doctor Simmons' series contains no case of cure after glandular involvement has taken place, these cases should be of considerable interest. In the second case there can be little doubt but that the post-operative toxin treatment was largely responsible for having kept the disease under control for so many years.

Dr. Martin B. Tinker, of Ithaca, N. Y., called attention to two phases of this question that had not been mentioned. One is the use of electrocoagulation and electric cutting in the removal of these malignant growths.

By electrocoagulation one can close off the lymphatics and the bloodstream and in that way lessen the risk of metastasis.

The second point which had impressed him was that the treatment of

certain of these cases is not surgical alone or radiological alone, but the combination, radiological and surgical. In some advanced cases not all of the growth was removed, and personally he does not any longer do extensive resections; but these patients afterward were given radium treatment immediately, not a long while after: in some instances the cures last for fifteen years.

The paper recently written by Doctor Forsell, of Stockholm, published in *Acta Radiologica, Supplementum two*, is in his opinion the most complete study that has been made with regard to the treatment of malignant growths by radium. Doctor Forsell emphasizes the point which I have tried to bring out, that in certain of these cases the best treatment is surgical, in some others radiological, and in still others a combination of surgery and radium gives the best results. He has also emphasized this point: that in the radium Hemmet at Stockholm the experienced men get a very much higher percentage of cures than the man who is without radium experience, and this work is delegated there to men who devote a large part of their time to it.

Doctor Tinker's own successes had come where the radium treatment had been given in places like that of Kelly at Baltimore and the Memorial Hospital in New York City where there are men who are devoting practically their entire time to the use of radiological methods of treatment.

PROFESSOR GUNNAR NYSTROM, of Uppsala, Sweden, said that they had made large investigations about the treatment of cancer in Sweden. The most extensive of them was made by the Cancer Society in the years of 1911 and 1913. About ten thousand cases of cancer were assembled from all the doctors, who gave the statistics of the results. This investigation of about ten thousand cases is a basis for the comparison now of the new results. Special investigations have been made as to cancer of the mouth, the surgical treatment and radiological treatment and combined treatment. There is a marked improvement in the results by this combination of which Doctor Tinker spoke, about 38 per cent. of cures by the surgical treatment alone and 50 to 60 per cent. by the combined treatment.

DR. CHANNING C. SIMMONS, of Boston, Mass., remarked that it is in the cases of cancer of high grade malignancy that radiation treatment is used. This type of tumor is radio-sensitive, and unless the growth is very small there is little hope of curing the patient by surgical procedures.

FURTHER OBSERVATION UPON THE COMPENSATORY USE OF LIVE TENDON STRIPS FOR FACIAL PARALYSIS

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Section or other type of transverse injury of the seventh cranial nerve proximal of the pes anserinus can, as a rule, be largely corrected by a nerve anastomosis, but even this is not free from trials both to the patient and the surgeon. If seen during the first twelve months after the damage is done, there may be some doubt as to the amount of spontaneous recovery to be expected, and even after an anastomosis is made, one may have to wait eight to twelve months before returning innervation is evident to the patient. It is not ordinarily practicable to do a suture of the smaller branches of the seventh nerve.

The most apparent objective evidence of a unilateral facial paralysis is not due to lack of movement of the paralyzed side so much as to the over-activity of the unparalyzed side and to a gravity sagging of the face on the affected side. The amount of this distortion varies considerably in individual cases but is as a rule most marked in the adult in whom a complete nerve severance has occurred in infancy or early childhood (Fig. 1). Even where there is a complete destruction of the nerve, in the removal of a malignant parotid tumor, which seldom happens before middle life, shortening the face tissues will largely control the distortion. Complete severance of the cervico-facial branch in the parotid is not very noticeable. Complete section of the temporo-facial division or even of the maxillary branch is more noticeable. It is possible to favorably influence the appearance of an evident hemiparalysis of the face by some means that will help to control the overaction of the unapposed muscles and the sagging of the unsupported face tissues.

Live strands of tendon leading through the face can be made to prevent the overactivity of the unaffected muscles, and can be used at any time, relieving a large amount of the visible damage. Even where a nerve transplant has been or is to be done, the tendon transplants take the edge off of the waiting period. With care, even total absence of the nerve can be almost completely hidden.

The paralysis of the orbicularis palpebrarum is compensated or camouflaged by the partial movement of the lids that is always present, but a sagging of the lower lid may suggest the need for some support at its base. This may be accomplished by running a fascia strand to the aponeurosis of the occipito-frontalis (Fig. 4-D and E).

The corner of the mouth can be lifted and the orbicularis oris anchored by tendon strips that engage in the face tissues at the temple or near the

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ear, and a tendon loop can be made to support the lower lid or any particular sagging feature. But a sagging of one side of the face as a whole may require a removal of some of the stretched tissue as well as tendon implantation, the former of which is helpful to almost all tendon insertions for a complete paralysis of one side.

For correction of the sagging lids, the "lift" may be extended across the brow to the mid-line (Fig. 5). The tendons should be put in carefully and in sufficient number. Experience has proved it is better to place all tendons before tightening any of them (Fig. 3–A, B, and c).

Habit distortion might not be entirely relieved by fixation of the unapposed muscle (Fig. 2–B and c). In some of these cases the distortion is not originally great, especially in partial paralysis, and the correction must be correspondingly accurate. The side view of patients so treated makes an interesting study (Fig. 1–c and D).

Illustrations, Figs. 1 to 9, on following pages:

Fig. 1-A.—Woman, with face in repose, who, at birth, had a lesion of the right motor facial nerve from which she made no recovery.

Note that the right eyebrow and upper and lower lids are at a lower level than on the left; that the right cheek and right side of the mouth have sagged downward; and that the lower part of the nose and both lips are drawn over to the left. The sagging of the brow, lids and cheek results from the toneless tissue yielding to gravity, but the displacement to the left results not only from a yielding of the paralyzed muscles to the normal pull of their opponents but appears to be partially due to an overactivity of the latter muscles, as if extra strong impulses were being sent through the normal nerve in an uncoördinated attempt to make up for the lack of movement of the other side.

It is the combination of these two displacements that causes the most evident deformity; when the paralyzed tissues are strengthened and held in their proper position, the patient can usually learn to control the overtone of the sound muscles and there is enough movement transmitted to the paralyzed side in any activity of the muscles of expression to camouflage the fact that the paralyzed side is without spontaneous movement. The incomplete working of the eyelids is the only evident reminder that remains.

Fig. 1-B.—Same patient as shown in Fig. 1-A, after the insertion of tendons and raising the face tissues by removing a strip of skin and subcutaneous tissue superficial to the parotid and temporal fascia immediately in front of the ear and in the hair-line of the temple. (See Fig. 5.) When we first undertook the use of fascial strips* for this purpose, we thought their proper insertion would be sufficient to fix the paralyzed tissues in the desired position, but, even after putting in the strips in a way to cause quite a bit of immediate over-correction, the latter was but partially successful, and it was found that a lifting of the face tissues to put greater traction on the tendons (Fig. 4-B and c), or the insertion of more tendons (Fig. 3-B and c) would be required.

In paralysis of long standing with as much sagging as is shown in Fig. 2, it is well not to attempt to "gather" all of the loose tissues with the tendon loops but to engage only the median three-fourths or more and remove excess, as described above, at the same operation.

Fig. 1-c and D shows the lateral view of the patient shown in Fig. 1-A and B and the amount of correction of the sagging obtained. Note that before the correction, the sagging of the cheek is so great that the vermilion borders of the corner of the mouth are not visible in profile.

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* Blair, V. P.: Notes on the Operative Correction of Facial Palsy. Southern Med. Journal,, vol. xix, No. 2, pp. 116–120, February, 1926.

FIG. I.
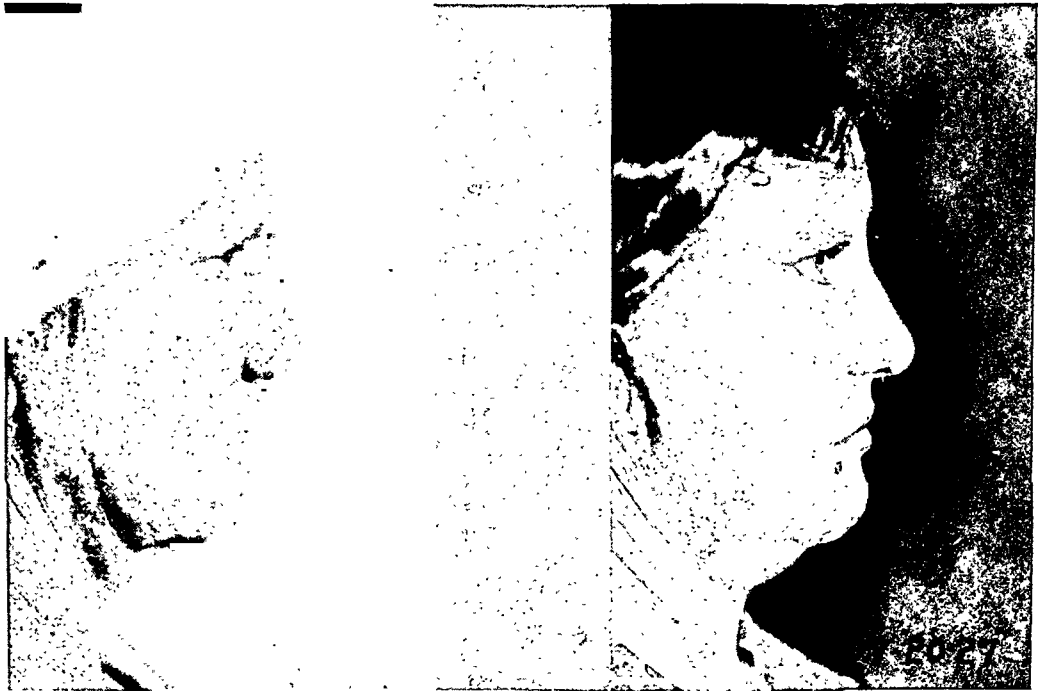
A   FIG. 2.   B

FIG. 2-A.—Patient, who, at eighteen months, had complete transverse lesion of the facial nerve with no recovery. She has an excessive sagging of the face, but, in repose, not much lateral distortion.

FIG. 2-B.—However, with any play of the facial muscles, there was a spasmodic overactivity that was very disfiguring.

In this patient, at the first operation, tendon loops were placed in the face and a wide strip of superficial tissue removed from in front of the ear and from the temple but, because she could not learn to overcome the habit of spasm, the inframandibular branch of the right nerve was later cut to stop the downward pull of that side of the lip.

C   D

FIG. 2-C.—Comparing Fig. 2-C with 2-B, it will be seen that, though sag has been removed from the cheek and upper lip, and that the philtrum and the centre of the lower lip remain in the midline, and that downward pull of the left lower lip has been eliminated, there is still considerable overactivity of the left buccinator. This is the only case of ours in which this overactivity of the sound muscles has remained objectionably evident after properly fixing the unparalyzed half of the orbicularis oris by tendon loops.

FIG. 2-D, shows the patient's face in repose after inserting the tendons and removing excess tissue on the right side. Note that the sagging of the right lower lid has been partially corrected. Note also a slight eversion of the right side of the lower lip due to the fact that the upper strand of the lower orbicularis loop was placed too far away from the free border of the lip.

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FIG. 3-A shows a young girl who had a complete lesion of the left facial nerve at birth. In this case, the brow on the unparalyzed side is the lower of the two, due possibly to a spasm of the orbicularis palpebrarum.

FIG. 3-B.—In this patient the attempt was made to correct the deformity by the use of tendon loops with the result shown in the above picture taken five months after operation.

FIG. 3-C.—Six months after the first operation, other loops to the corner of the mouth and to the upper and the lower attachment of the orbicularis were inserted, again with over-correction. While the mouth now remains straight and in the mid-line, it will be seen that the "gathered" fullness of the cheek on that side is still quite apparent. The final condition of the eye in this and the two preceding cases will be referred to later.

FIG. 4–A shows a young woman who had her right facial nerve cut distal to the division at the "Pes." A subsequent nerve-suture had been attempted and abandoned before entering this service.

FIG. 4–B shows the result of inserting tendon loops with great immediate over-correction.

FIG. 4–C shows final result obtained in part by a subsequent removal of a strip of face tissue from in front of the ear, from the temple, and also along the hair-line of the forehead to across the centre of the brow. At the same time the right side was undermined to allow of freer raising of the forehead tissues and of the tendon that loops around the lower lid. See Fig. 4–D and E.

FIG. 4–D.—Same case as shown in Fig. 4–A before operation, but with the eye shut. Note that the brow and fissure are both markedly displaced downward.

FIG. 4–E shows the result of the operation described under Fig. 4–C. Note that the brow and fissure are at the same level as their fellows and that the vertical extent of the fissure when closed is very much less than in 4–D.

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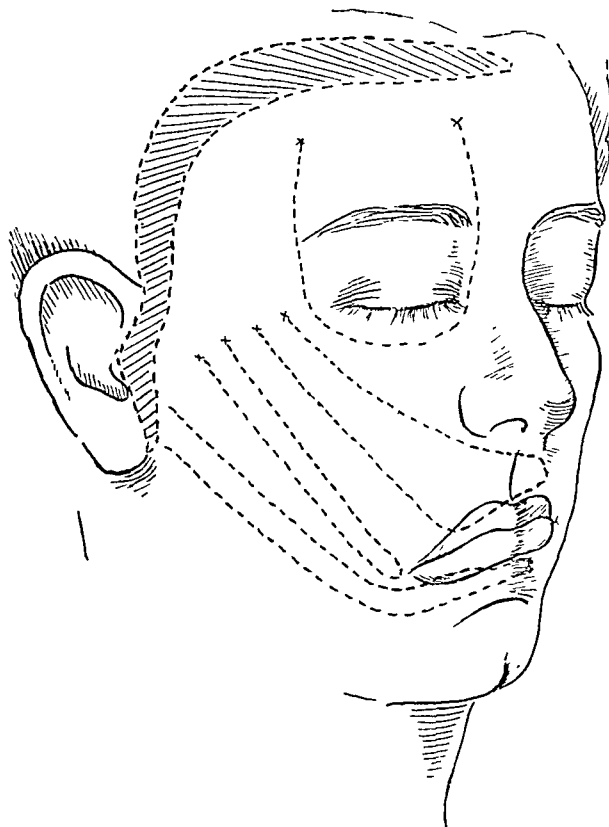
FIG. 5.—For illustration of enlarged Reverdin needle which we use for inserting these loops, see original article.*   The slight modification of the opening and closing mechanism which we resorted to gives leverage in moving the stilet through the irregularly curved tube, and the changes of position of the lever are so evident that, even under the stress of putting in the loops without contamination, one is less apt to withdraw the needle without closing the eye.

The forehead—infra-orbital loop—may be inserted with the Reverdin needle along the base of the lower lid at the level of the infra-orbital border. This can be done with the large Reverdin needle through a small supplementary incision opposite the middle of the infra-orbital border but it is better to use a large "surgical" needle or a specially shaped old-fashioned "perineal" needle on a handle. Fig. 5 also shows a general plan of excision for the excess tissue.

To insert the upper loop, a five-millimetre incision is made well through the skin at a point external to the outer canthus, and another is made vertically, halfway through the orbicularis muscle just beyond the border of the philtrum on the opposite side. The opposite side of the upper lip is fixed by grasping it with a Jacobs forceps which is left locked in place. The unthreaded needle enters at the upper opening, traverses the cheek deeper than the skin, passes deep to the ala labial crease and traverses the lip equidistant from the skin and the mucosa. It emerges through the cut on the other side of the philtrum; one end of a strand of fascia is locked in, and the needle withdrawn, the protruding lip-end of fascia being held with a forceps and protected from salivary contamination by damp gauze; the upper end of the strip is fixed to a damp gauze pad with an artery forceps, the pad itself having been previously fixed to the head towel—this to prevent accidental withdrawal of the strand. The empty needle is then reinserted through the upper incision and traverses the cheek at a lower level than previously. It passes close to the corner of the mouth within a few millimetres of the mucosa of the vermilion border to emerge through the original opening in the lip. The other end of the same tendon is locked in and the needle withdrawn. A Jacobs forceps is locked on the lower lip and, after making appropriate skin incisions, this same procedure is repeated in placing the fascia loop to the corner of the mouth and in the lower lip. In placing the lower lip loop, the upper bar of the loop must run close to the corner of the mouth and just within the vermilion, and the lower strand must be in the movable part of the lip, not in the more fixed tissues of the chin.

The loops are all placed before any are tightened and fixed, and the Jacobs forceps remain locked in the upper and lower lips to assist in the over-correction in tightening and fixing the loops. The exact position of the lip and corner of the mouth loops may change in different cases but the close approximation of lower strand of the upper, and upper strand of the lower lip loops to their respective vermilion borders is a matter of importance.

The positions of the incisions of insertion will vary with the amount of sagging and will also be governed by the length of the tendon strands. Short strands can be spliced with split silk, but it is advantageous to use a single loop when practicable.

* Blair, V. P.: Notes on the Operative Correction of Facial Palsy. Southern Med. Journal, vol. xix, No. 2, pp. 11–120, February, 1926.
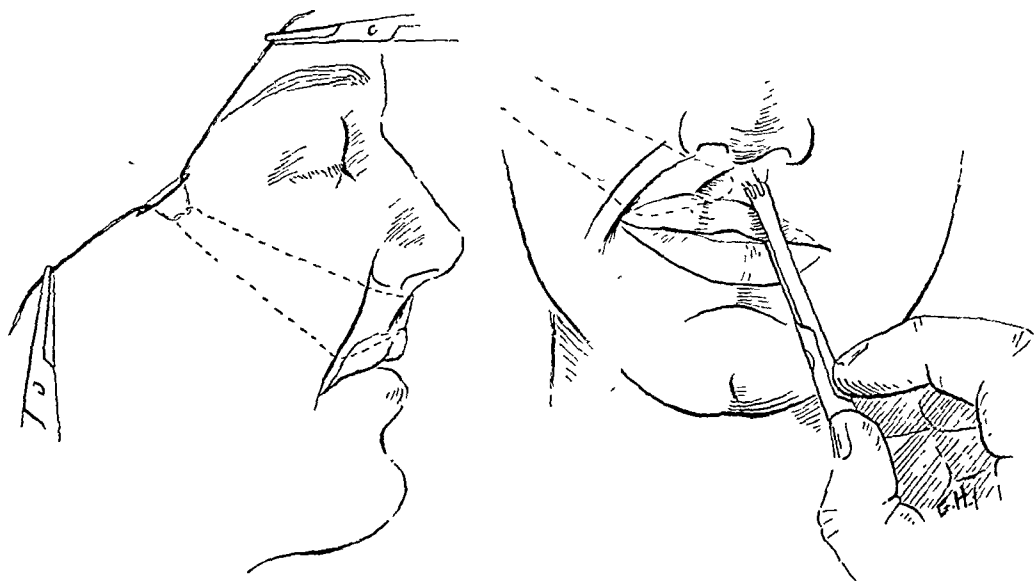
FIG. 6.—Drawing the lips over towards the paralyzed side by means of the Jacobs forceps, the two lip and the corner-of-the-mouth loops are each in turn tied in a single knot, Fig. 6, which slips into the tissues through the skin incision and is drawn taut until there is about 1 centimetre of over-correction.
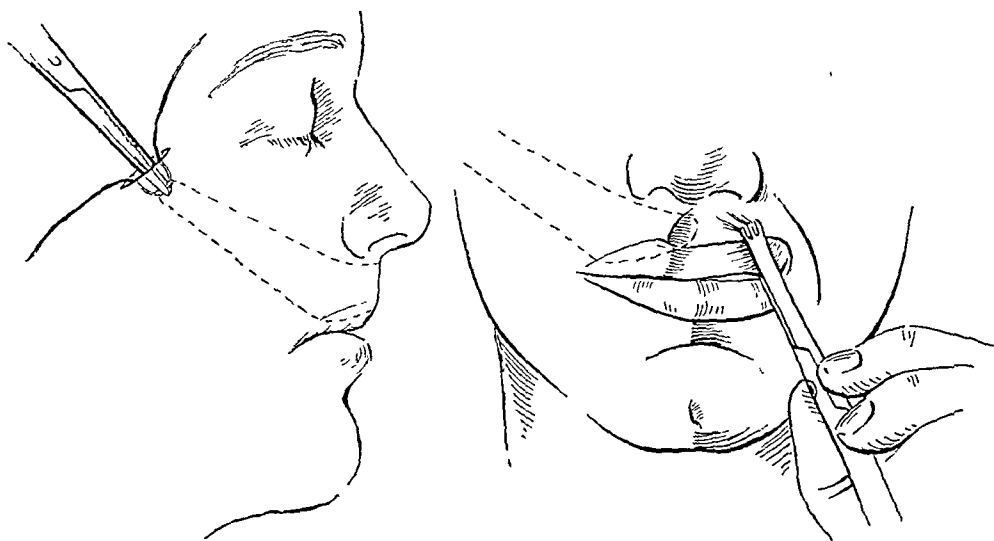
FIG. 7.—The knot is grasped with a mouse-toothed mosquito forceps and, with the Jacobs forceps in the lip, is drawn upon in the reverse direction to see that the knotted loop maintains the over-correction. If this test proves satisfactory, the tension on the Jacobs forceps is released, and the knot still held in the jaws of the mouse-toothed forceps is withdrawn from the skin incision.
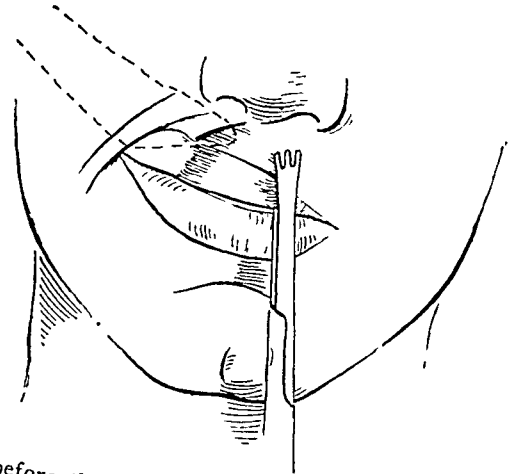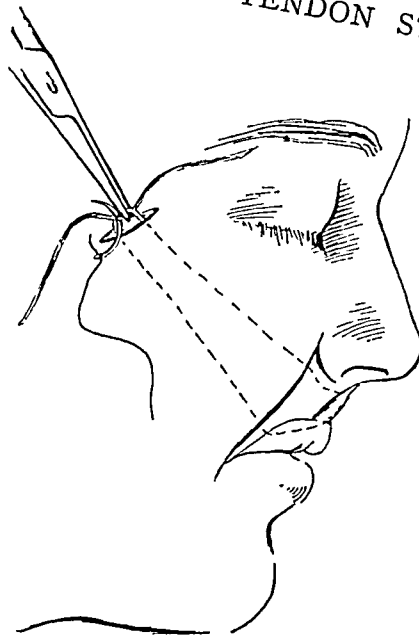
FIG. 8.—The knot is fixed with a few fine silk sutures before the forceps are removed, and then dropped back in the wound. The fixation is again tested by gentle traction on the Jacobs forceps.
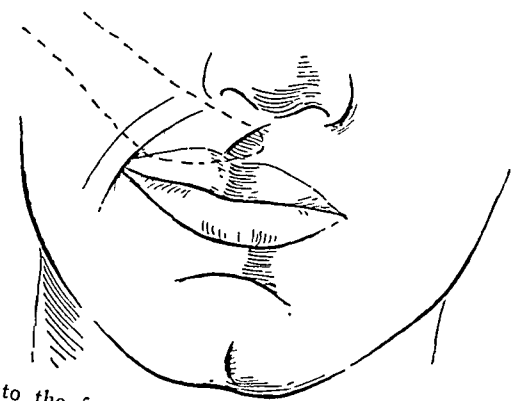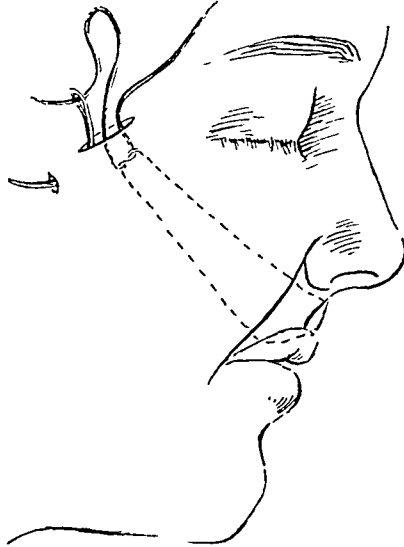
FIG. 9.—The free ends are buried by drawing them into the face tissues with a Reverdin or a large-eyed surgical needle, and the incision closed with a horse-hair suture.
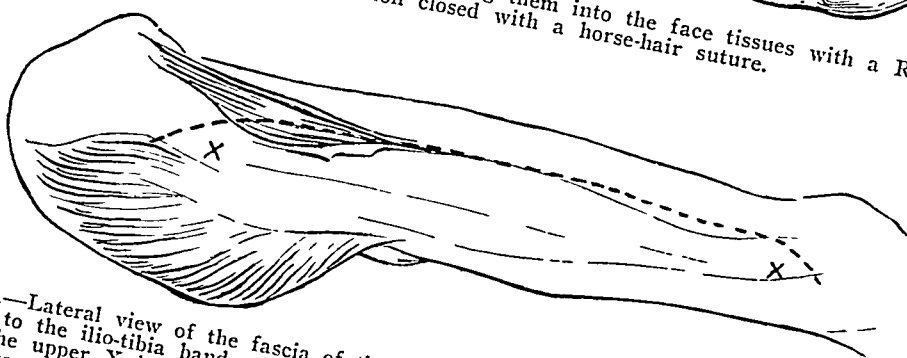
FIG. 10.—Lateral view of the fascia of the thigh. The dotted line shows position of the skin incision down to the ilio-tibia band. It is from between the two XX's that the longest strip can be obtained. The upper X is situated between the posterior border of the tensor-fascia femoris muscle and the greater trochanter of the femor. We try to get these fascia strips fifteen to eighteen inches long and less than an eighth of an inch wide, and they should be cut in the line of and not across the fibres of the ilio-tibia band.

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ENTEROANASTOMOSIS IN INTESTINAL OBSTRUCTION

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So voluminous is the literature upon the subject of intestinal obstruction that it is approached with much hesitancy. However, after a rather comprehensive review of the cases which have come under the attention of the writer during the past few years, certain observations have resulted which, while probably adding nothing new to the handling of this distressing condition, yet have not been sufficiently stressed to render their importance impressive.

By intestinal obstruction is meant a more or less complete blocking of the intestinal tract at any level between the duodenum and the anus. When the block is in the jejunum or upper ileum it is customary to designate the condition as "high obstruction," while the term "low obstruction" is employed when the lower ileum is involved. The latter term is also used when the obstruction is located in any portion of the large bowel.

Such a division is entirely arbitrary and of but little value except that it has been observed that high obstruction is usually more rapidly fatal than low obstruction. This has been explained because of a belief that the toxins developed in the intestine are more virulent in the higher portions. It is a demonstrated fact that any protein can primarily be split up into a very toxic and a non-toxic substance, and that these must be reduced to far simpler substances before being available for absorption, which, however, is not proof that the poison radical is ever absorbed as such.

That starvation is more rapid and complete in high obstruction than in low, is easily understood when we stop to refresh our memories concerning the normal physiological functions of the different intestinal levels.

Metabolism of carbohydrates begins through the catalytic action of ptyalin found in the saliva. This splits starch into maltose and glucose. This carbohydrate digestion begins in the mouth and is continued in the stomach until finally inhibited because of an excess of hydrochloric acid. It is again resumed in the small intestine through the action of the amylase of the pancreatic juice. Here the enzyme invertase converts cane sugar into lævulose and glucose. Fats are not digested appreciably until they have reached the duodenum, where the pancreatic juice and bile split them into fatty acids and glycerins. While the carbohydrates after proper preparation pass into the portal system, the fats are taken up into the lacteals of the intestinal villi and then into the thoracic duct, thus short-circuiting the liver. Proteins, which are essential constituents of all living tissue, are digested first in the stomach through the action of pepsin and hydrochloric acid. Here digestion progresses only to the peptone stage, after which it passes into the intestine. Here

trypsin and the alkali content continue digestion until polypeptides and amino-acids result, in which form they can be utilized.

From this brief review it can be seen that but little food value can be obtained from either carbohydrate, fat or protein until these substances have passed a considerable distance along the course of the small intestine from which it can be deduced that starvation is more rapid and complete the higher the obstruction. Of at least equal importance is the function of the large intestine in maintaining a water balance through its power of absorbing water from its content. Any interference which causes complete loss of this function means rapid dehydration and death. We know that a comparatively small portion of large bowel can carry out this process satisfactorily, but a small amount of active large intestine is essential. Temporarily dehydration can be partially prevented by the subcutaneous and intravenous administration of fluids, but the water balance cannot be maintained in this manner indefinitely. That this matter is one of extreme importance can be shown by a review of certain cases, and the results obtained where this function has been maintained through the use of enteroanastomosis in preference to enterostomy.

In the presentation of the following cases only the briefest mention of essential points is made. Complete laboratory and clinical records are available, but a detailed report of each case would only be wearisome and add nothing to the conclusions deduced.

CASE No. 3481.—S. A., March 9, 1925, a hysterectomy had been performed because of a large fibroid jammed in the pelvis. The appendix was also removed. All raw surfaces were well peritonized. Vomiting persisted after operation and March 13 it was decided that intestinal obstruction had resulted. The old incision was opened. The small intestine was markedly distended and of a bluish color. It was adherent to the lower angle of the wound, which apparently was the cause of the obstruction. This was separated and an enterostomy performed above this point. Decided improvement was noted for three days, after which obstructive symptoms again recurred. March 18 a high enterostomy about six inches below Treitz's ligament was made. Again there was decided improvement. The pulse rate was lowered from twenty to thirty beats per minute and vomiting ceased. Flatus and fecal matter were passed by rectum. Improvement continued until the twenty-third when the enterostomy tube became loose, wound infection resulting. Rapidly the patient's condition became worse and death occurred upon the twenty-fifth, twelve days after the last enterostomy.

Impression.—In spite of the copious subcutaneous administration of saline and the intravenous injection of hypertonic salt, the patient became rapidly dehydrated and succumbed because of an infection which ordinarily would have been considered as slight.

CASE No. 2668.—Mrs. S. W. entered the Detroit Diagnostic Hospital suffering from intestinal obstruction of two days' duration. There had been no previous abdominal operation. Operation December 6, 1926, showed about 200 cubic centimetres of serous fluid in the abdominal cavity. The small bowel was distended, but not discolored. A Meckel's diverticulum, three-quarters inch in length, was encountered, but not disturbed as the obstruction was farther down near the ileocecal valve. At this point the small intestine was encircled by a small strip of omentum, which caused almost complete constriction. Cutting of this band relieved the obstruction, the small bowel immediately filling to the cæcum. In spite of the apparently favorable findings and the slight manipulation, the patient continued vomiting. December 8 low enterostomy was performed. This was followed by improvement lasting three days, after which obstructive

symptoms again developed. December 13 a high enterostomy was made. Vomiting ceased and improvement was marked until the enterostomy tubes loosened. · Again wound infection resulted and December 21 the patient succumbed.

Impressions.—Again death resulted from a comparatively slight infection after the loosening of the enterostomy tubes, as well as the observation that low enterostomy is sometimes followed by a plastic peritonitis, which results in a second obstruction above the point of enterostomy. This observation has been mentioned by others and observed many other times by the writer.

CASE No. 193.—Mr. H. F. entered the hospital August 13, 1923, with signs of intestinal obstruction. There had been no previous operation. Upon opening the abdomen there was considerable free fluid and the small bowel was markedly dilated. There were several small hæmorrhagic areas in the bowel. The obstruction was evidently the result of adhesions resulting from a chronic appendix, which involved both intestine and omentum. These were separated and the appendix was removed. . Vomiting continued and the obstructive signs were not relieved. August 19 a high enterostomy was performed, which disclosed a new obstruction resulting from the plastic peritonitis present. Death occurred suddenly a few hours later, the immediate cause probably being the aspiration of vomitus.

Impression.—This represents another case in which a second higher obstruction followed the plastic peritonitis resulting from the first.

CASE No. 11.—A. L. had previously been operated upon for the removal of an acute purulent appendix. April 26, 1923, he entered the hospital with symptoms of intestinal obstruction. Operation proved this to be true, the omentum being adherent to both intestine and parietal peritoneum so as to cause three distinct obstructive points in the terminal foot of ileum. Adhesions were freed and the omentum resected. Recovery, which was uneventful, was followed one month later by the recurrence of obstructive symptoms. These became more pronounced and then again complete. September 19 the abdomen was again opened, and it was found that the terminal three feet of small intestine were so matted that resection was thought advisable. The patient progressed favorably until September 23, when vomiting, which soon became fecal, recommenced. At this time an enterostomy above the point of resection was made. Improvement was again noted until the enterostomy tube was removed. This was followed by slight wound infection, which resulted in death October 13.

Impression.—An enteroanastomosis sidetracking the obstruction, performed at the first operation, would probably have resulted differently. A subsequent case will illustrate this point.

CASE No. 4013.—H. C. was relieved of an acute purulent appendix October 13, 1928. Five days later, signs of obstruction developed. October 19 the wound was reopened and adhesions were observed, which had caused a twisting of the small intestine near the ileocecal valve, the bowel being markedly dilated above this point. The adhesions were separated and an enterostomy performed above the obstructive point. This was followed by the relief of symptoms for a period of three days after which they recurred. October 25, a high enterostomy was performed, which revealed a higher obstruction due to plastic peritonitis. The patient showed decided improvement and took nourishment well. After removal of the enterostomy tube he began to fail, and died November 1.

Impressions.—Here again is a case in which enterostomy was followed by a second higher obstruction due to plastic peritonitis. In spite of the use of hypodermoclysis and hypertonic saline, as well as numerous blood transfusions, the patient became much dehydrated and succumbed following slight wound infection.

CASE No. 1159.—M. G. had been operated upon December 30, 1924, because of an acute purulent appendicitis. January 20, 1925, she entered the Detroit Diagnostic Hospital because of intestinal obstruction. At this time adhesions were separated.

March 25, 1925, the patient returned because of definite recurrent obstruction. The small bowel was obstructed as well as the transverse colon, which was involved in the adherent mass. Again the adhesions were separated and the omentum so placed and sutured as to aid in the prevention of recurrence. May 25, 1925, the patient re-entered the hospital with complete obstruction, which was located in the ileum one foot from the cæcum. At this time a lateral anastomosis was made between the ileum above the obstructed point and the mid-portion of the transverse colon. The patient left the hospital June 11, feeling much improved. July 7, 1925, she again entered the hospital because of obstruction. At this time it was found that the anastomosis was closed because of adhesions and a second anastomosis was made four inches proximal to the previous one. She left the hospital July 24 apparently relieved. November 16, 1925, symptoms of obstruction having recurred, adhesions between the abdominal wall, omentum and the anastomosis were separated.

February 4, 1926, obstruction recurred. The abdomen was opened and an anastomosis was made between the upper sigmoid and ileum, thus widely sidetracking the adherent mass. After this, symptoms were much improved, except for violent and almost continuous headaches. March 11, 1926, a resection of bowel beginning at the small intestine distal to the last anastomosis was made. This was performed in two stages, the first operation consisting in simply dividing the small intestine and inverting the end near the anastomosis, while the distal end of the small bowel was brought out through the wound. The second stage was accomplished April 15, 1926, when the free end of small intestine, the cæcum, ascending and transverse colon were removed. The patient was free from trouble until September 27, 1926, when vomiting recurred. In October this was again observed and at this time the patient insisted that the vomiting was associated with menstruation. Radiographs showed no obstruction.

January 22, 1929, definite obstructive signs recurred and the abdomen was opened once again. The small intestine was found adherent to the abdominal wall about two feet above the anastomosis. The lumen was almost obliterated and the bowel was torn in the attempt to free it. Resection of three inches and end-to-end anastomosis were done. At this time it was observed that the abdomen was remarkably free from adhesions. Since this time the patient has remained perfectly well and has gained many pounds in weight.

Impressions.—Clinically, this patient improved much more rapidly after enteroanastomosis than any case ever had after enterostomy. Convalescent dehydration was not observed, even though her primary condition was much worse than in cases where death had resulted after simple enterostomy.

CASE No. 3379.—G. B. had been operated upon December 12, 1927, because of an acute retrocecal appendicitis. The appendix was ten inches long and very adherent. The wound had become infected. June 9, 1928, he suffered an attack of vomiting, which lasted two days. October 28, 1928, he entered the hospital after four days of vomiting, which had become fecal in character. On opening the abdomen free fluid was present and the small intestine was greatly distended and spotted with hæmorrhagic areas. An omental band was found which caused low intestinal occlusion. This was severed and an enterostomy made above the obstructed point. The condition of the patient improved gradually until November 20, when fecal vomiting again recurred. The abdomen was opened and a second obstruction found one foot above the enterostomy. Two feet of intestine were resected and an end-to-end anastomosis made. However, fecal vomiting continued and the patient became rapidly worse. November 23 a high right rectus incision was made and the small intestine above the previously obstructed point was anastomosed to the colon at the hepatic flexure. The opening was about two and one-half inches. Vomiting ceased and recovery progressed uneventfully. The patient has since claimed excellent health, although there is present a fascia separation, which requires the use of a belt.

Impressions.—This is probably the most advanced case of intestinal obstruction that I have ever seen recover, and it would seem that the enteroanastomosis and early reëstablishment of water balance played an important part in the result.

CASE No. 2111.—E. P. had been operated upon for the removal of the appendix about two years previously. This operation had been performed in an eastern hospital and no record of the condition found was available. He entered the hospital April 2, 1926, because of intestinal obstruction of two days' duration. Operation disclosed adhesions between omentum and terminal ileum one inch from the ileocecal valve to be responsible. These were separated and the omentum resected. Recovery was stormy for three days, then uneventful.

December 21, 1928, the patient again entered the hospital because of intestinal obstruction. The small intestine was found to be glued into an obstructive mass for a distance of six inches from the ileocecal valve. The adhesions were separated, leaving much raw surface on the intestine. Fearing a rapid recurrence, an ileocecostomy was performed, sidetracking the denuded area. Recovery was uneventful, and the patient has remained well since.

The above case is representative of two similar ones in which similar results were obtained.

CASE No. 4365.—M. R. had been operated upon April 22, 1929, for the removal of a large impacted fibroid. In September of the same year she was seen because of a partial intestinal obstruction, which relieved itself. Symptoms, however, recurred and October 12, 1929, the abdomen was opened because of complete obstruction. A considerable portion of small intestine was adherent in the pelvis. While attempting to free these adhesions the intestine was badly torn. The tear was closed with a double layer of sutures and a lateral anastomosis made between small intestine at a point above the obstruction and the transverse colon. The patient showed rapid improvement, but still suffered from recurring attacks of abdominal pain and vomiting. December 19 the second stage of the operation was performed. This consisted in the removal of the small intestine from the point of anastomosis to the cæcum, which was adherent in the pelvis. This portion was nine feet long and many obstructive points were encountered forming dilated bowel areas filled with fecal matter and pus. So adherent and friable was the bowel that its lumen was opened three times during the dissection. The end of the small bowel near the anastomosis was inverted, while a short portion left to the cæcum was attached to the lower angle of the wound, the patient's condition making inadvisable the removal of the useless portion of large intestine at that time.

Parenthetically, resulting observations have been of interest. As long as the patient was confined to bed all bowel movements occurred normally, even though radiographic examination showed a filling of the inactive portion of the large intestine after a barium meal. However, as soon as the patient assumed an upright position and began to walk, gravity played a more important part, and fecal matter was occasionally discharged through the cecal fistula.

Another interesting observation was that the shortening of the small intestine has so interfered with the digestion of some foods that they always appear in recognizable form when eaten. Other foods are completely digested, thus showing that digestion of certain foods occurs simultaneously with absorption of others at certain intestinal levels. Further observations are contemplated.

At present this patient is in excellent health, eating well of a regulated diet and having gained many pounds.

CASE No. 1319.—M. L. This case is mentioned simply because it is one of several and represents a type. The only unusual thing about the case is the patient's age, which was eighty-three when she was first seen, with complete obstruction of two days' duration, due to a carcinoma at the junction of the rectum and sigmoid. Colostomy was performed six inches above the tumor. The patient lived five years in comfort, dying but a week ago from a coronary thrombosis.

The mortality rate in cases of intestinal obstruction treated by enterostomy has been approximately 40 per cent. In contra-distinction to this our records show six cases of low small intestinal obstruction treated by enteroanastomosis without a fatality, many of which were much further advanced than some which proved fatal after treatment by enterostomy.

In conclusion, I would state that the factor of water balance is of decided importance. Subcutaneous and intravenous administration of fluids aids decidedly and the use of hypertonic saline is of extreme value; yet, in spite of all these aids, dehydration eventually occurs unless the physiological action of the large bowel is re-instated.

By preference we now treat high obstruction, which is rare, by means of enterostomy and relief of the obstruction, the enterostomy being closed at the first manifest improvement in the patient's condition.

Low obstruction, including the transverse colon, is preferably handled by sidetracking the obstruction through enteroanastomosis, subsequent resection being done when indicated, and obstruction below this point is best cared for by means of colostomy.

DISCUSSION: DR. THOMAS G. ORR, of Kansas City, Mo., remarked as to the poor results obtained by simple high enterostomy, that it is a fairly well-known fact that in experimental animals, if the upper jejunum is drained death results in a few days. He had run a series of experiments in animals doing a simple jejunostomy and in a second series obstructing the gut and doing a jejunostomy as a part of the treatment. The animals died much more quickly with a simple jejunostomy than they did if they obstructed and waited for a few days before doing the jejunostomy. In other words, he thought with a jejunostomy the animals died much quicker than with the simple obstruction.

The cause of death in intestinal obstruction is still undecided. He was very suspicious, however, that the loss of the upper intestinal tract secretions is much more important than the question of any absorption of toxin from the obstructed gut.

While the administration of sodium chloride and water will unquestionably prolong life in intestinal obstruction, there is another element in the disease which is not replaced by this treatment. The loss of other secretions into the gut above, especially the pancreatic secretions, appear to be important. Jejunostomy should be used with a good deal of care, because of this particular danger. Professor Wilkie discussed this last year and showed very definitely that by draining the upper jejunum into the gut below that he was able to save patients.

Dr. Rader of Omaha has treated a number of patients in which he anastomosed the ileum to the sigmoid with success, thereby avoiding the extensive external drainage of the upper intestine. Loss of upper gut secretions is very intimately bound up with the question of the cause of death, and deserves considerable study. I believe that too much emphasis has been placed upon jejunostomy as a treatment in acute intestinal obstruction.

SECTION OF THE SYMPATHETIC NERVES OF THE DISTAL PART OF THE COLON AND THE RECTUM IN THE TREATMENT OF HIRSCHSPRUNG'S DISEASE AND CERTAIN TYPES OF CONSTIPATION

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It appears to be established that interruption of the sympathetic nerve supply to the large bowel is of benefit in selected cases of idiopathic dilatation of the colon. Hitherto, such interference has been either lumbar gangli-
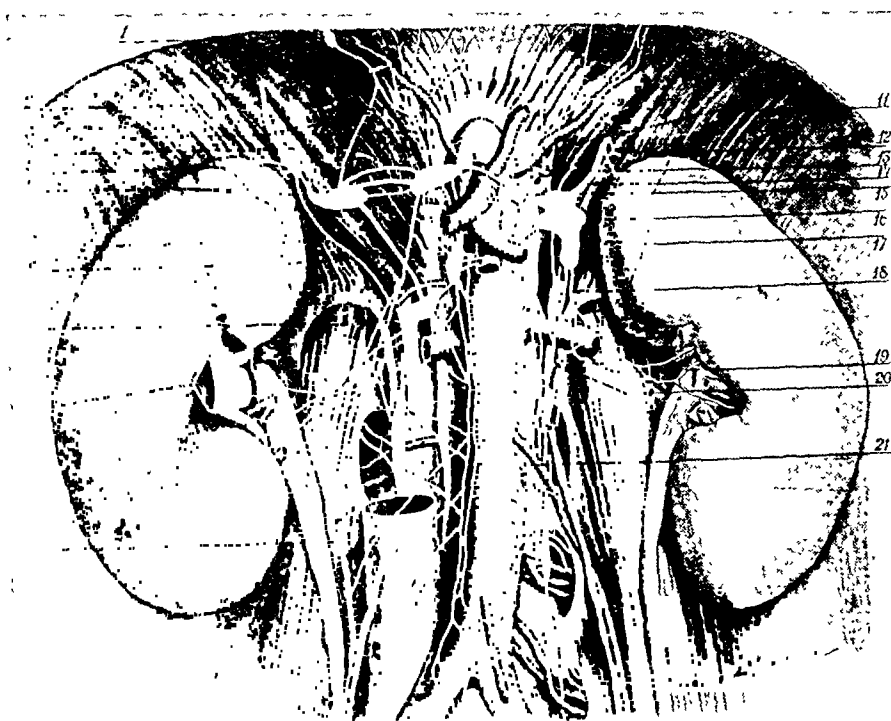
Fig. 1.—The formation of the intermesenteric plexuses: Branches from the semilunar ganglia (6 and 16), the celiac ganglion, and the renal periarterial plexuses (20) form two or more intercommunicating trunks on each anterolateral aspect of the aorta; branches from the second lumbar ganglion join the trunks on the right side. The roots of the inferior mesenteric nerves arise from the intermesenteric plexuses. (Taken from Hovelacque.)

onectomy and ramisectomy, in which the second, third and fourth lumbar ganglia, with their connecting trunks and communicating branches, have been removed on both sides,[5] or an operation on the left side,[11] in which "the white ramus from the first lumbar nerve to the first lumbar ganglion and, if there was a large branch from the second nerve to the second ganglion, this also was divided. All the branches (usually four) leaving the

ganglion on the medial side, and one from the first and second ganglia, and one or two smaller ones from the fourth have been severed and the cord has been cut across below the fourth ganglion."[10] As a result of closer study of the anatomy and physiology of the nerves passing to the distal part of the large bowel, it has been possible to simplify the operation so that the nerve section is limited to the actual fibres supplying the intestine; only this procedure insures the interruption of all the fibres reaching the distal part of the colon from the thoracicolumbar sympathetic outflow. The operation has also been applied in a case of obstipation in which the cause of difficulty was lack of tonus in the rectum.

Anatomy of the sympathetic nerve supply to the distal part of the colon and to the rectum.[4]—The sympathetic nerves which pass to the distal part of the colon have for their immediate origin the inter-mesenteric plexuses (Fig. 1). These networks of nerves descend on the anterolateral aspects of the abdominal aorta, from the level of the origin of the superior mesenteric artery downward. On each side there are two or three large trunks, which are made up of nonmyelinated

FIG. 2.—Delmas' conception of the distribution of the sympathetic system. The pelvic splanchnic nerves, derived from the four lumbar sympathetic ganglia, supply only pelvic viscera. This may be compared with Figure 1, in which branches from the lumbar ganglia are shown joining the intermesenteric plexuses. (Redrawn from Delmas.)

fibres, arising from: (1) the semilunar ganglion and celiac plexus; (2) an anastomotic loop which crosses the aorta transversely, below the origin of the superior mesenteric artery; and (3) the aorticorenal ganglion, or the renal periarterial plexus.

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The intermesenteric plexus is joined on each side by branches from the first and second lumbar ganglia. These branches contain myelinated fibres; those on the right side pass between the vena cava and the aorta to reach the front of the latter vessel. The fibres which form the intermesenteric plexuses are thus derived from two sources: their original fibres spring from that part of the abdominal sympathetic system connected with the thoracic splanchnic nerves, while the branches which the plexus receives as it descends along the aorta spring from the lumbar ganglia or trunks. There is a difference of opinion among anatomists concerning the extent to which the lumbar fibres mingle with those of the intermesenteric plexus proper. According to Delmas, Laux, and others, the mesially-directed lumbar communicating branches, constituting the pelvic splanchnic nerves, remain distinct in the outer part of the plexus (Fig. 2), and ultimately form the lateral roots of the presacral nerve of Latarjet (superior hypogastric plexus of Hovelacque). On the other hand, Hovelacque holds that these lumbar communicating branches actually contribute to the intermesenteric plexus (Fig. 1). The point is one of great significance. If the former view were correct, lumbar ramisectomy and ganglionectomy would affect only that portion of the bowel innervated through the presacral nerve; namely, the lower part of the rectum and the internal sphincter of the anus; if the latter arrangement were the true one, it would affect, but only partly, the descending and sigmoid portions of the colon,* as well as the rectum and the internal sphincter of the anus. The beneficial results of lumbar ramisectomy in cases of Hirschsprung's disease strongly favor the view that the branches which join the intermesenteric plexus from the first and second lumbar ganglia do have a share in the innervation of the colon.

Immediately below the level of the origin of the inferior mesenteric artery, a large branch leaves the intermesenteric plexus of each side, and passes inward, on the aorta, to reach the inferior mesenteric artery about 1.5 centimetres from its origin (Fig. 3). Finally these two trunks unite, and give rise to three or four large branches which course along the lateral borders of the vessel, communicating at intervals with each other. Fortunately for the surgeon, the nerves associated with the inferior mesenteric artery retain their individuality, and neither form so close a network, nor possess such an intimate relationship with the wall of the vessel, as do the nerves supplying other viscera. From these nerves subsidiary trunks arise at the levels of the main divisions of the artery. Soon, however, they abandon the vessels, and anastomose with one another in avascular parts of the mesosigmoid. From this network the final nerves of distribution are derived; these slender filaments cross the juxtacolic vascular arcades, and enter the wall of the bowel between the terminal branches of the vessels. Two or three large branches accompany the superior hæmorrhoidal artery, and invest the lateral and posterior walls of the rectum in a plexiform manner. Their

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* In the dog, there is no doubt that the communicating branches from the lumbar ganglia play an active part in the innervation of the colon.[8]

terminal twigs join the hypogastric ganglia. The distribution of the inferior mesenteric nerves corresponds to that of the inferior mesenteric artery, and toward the end of the transverse colon, where the left colic artery anastomoses with the middle colic, branches of the inferior mesenteric plexus communicate with filaments derived from the superior mesenteric plexus.

It has been seen that the inferior mesenteric nerves are formed in greater part of post-ganglionic fibres. If the lumbar communicating branches contribute to the plexus, there should be a ganglion about the root of the artery, in which their myelinated fibres effect synapses. There is no doubt that there are ganglionic masses in this area, but they are most inconstant, both
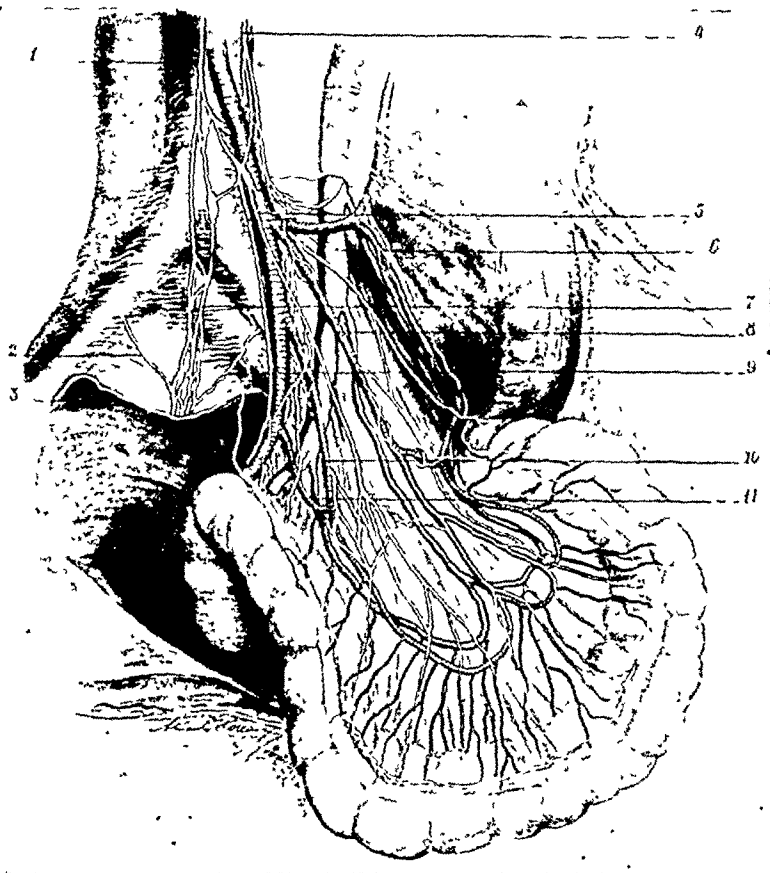
Fig. 3.—The inferior mesenteric nerves: _1_, intermesenteric nerves of right side; _2_, branch from right fourth lumbar ganglion to presacral nerve; _3_, cut edge of peritoneum; _4_ intermesenteric nerves of left side; _5_, inferior mesenteric nerves; _6_, inferior mesenteric vein; _7_, presacral nerve; _8_, sigmoid artery; _9_, branch from left fourth lumbar ganglion to presacral nerve; _10_, sigmoid artery, and _11_, sigmoid artery. (Taken from Hovelacque.)

in position and in size. In the fœtus and in the child, a ganglion is present at the root of the artery,[3] where it has been identified in serial sections of embryos at the sixth week of gestation. As development proceeds, and new neuronic connections are established, the ganglion becomes less demarcated. When present it is most often found below the origin of the artery,[4] at the juncture of the two parts of the intermesenteric plexus, after they have given off the nerves to the colon; that is, apparently only indirectly connected with the inferior mesenteric nerves.

Anatomy of the sympathetic nerve supply to the rectum and to the internal sphincter of the anus.—In some cases of Hirschsprung's disease the

dilatation of the large bowel extends to the internal sphincter of the anus, so that it has been suggested that this structure may offer undue resistance to the expulsion of the contents of the bowel. In vertebrates the internal sphincter of the anus is innervated through the thoracicolumbar sympathetic outflow.[2] In man, there are two possible paths by which thoracicolumbar fibres might reach the sphincter: (1) by way of the inferior mesenteric nerves, their superior hæmorrhoidal branches, and the branches of distribution of the hypogastric ganglia; and (2) by way of the presacral nerve (superior hypogastric plexus), and the branches of distribution of the hypogastric ganglia.* The first route has been described. The presacral nerve is a complex nerve, lying in the angle between the common iliac arteries. It has three roots.[7] On each side, succeeding branches arising from the first to the fourth lumbar ganglia join to form its lateral roots, which converge toward the anterior aspect of the fifth lumbar vertebra. Into the angle between the two lateral roots descends the third or middle root, which consists of the terminal part of the intermesenteric plexus. In 20 per cent. of cases the presacral nerve is single; in the remaining 80 per cent. the three roots form a more or less intricate plexus between the common iliac arteries. The nerve descends into the pelvis, and at the level of the first sacral vertebra divides into the two hypogastric nerves, which join the corresponding hypogastric ganglia. From these, post-ganglionic fibres of distribution pass to the pelvic viscera, including the lower part of the rectum and the internal sphincter of the anus.

Physiology of sympathetic nerve supply to the distal part of the colon, the rectum, and the internal sphincter of the anus.—It is generally accepted that the fibres of the inferior mesenteric plexus which end in the musculature of the colon and rectum carry impulses which inhibit its activity. Further, it would appear probable that these nerves keep up a continuous influence on the tonus of this portion of the bowel; in the dog, section of the corresponding nerves always leads to an immediate increase in intracolonic pressure.[9] With regard to control of the internal sphincter of the anus, it has been found in experimental animals,[8] and in man (Case II), that the thoracicolumbar outflow provides the motor supply for this muscle.

The basis of the suggested operation—In Hirschsprung's disease.—We do not wish to make a critical examination of the numerous suggestions which have been offered as the cause of idiopathic dilatation of the colon; in our opinion that of neuromuscular dysfunction seems most reasonable in a large number of cases. Rather, we shall consider the essential pathologic anatomy of the lesion. The colon is dilated, and the dilatation is most marked in its distal part, sometimes reaching the internal sphincter of the anus. Although the muscular coat is hypertrophied, it is unable to transmit the content of the intestine. Even if, in our ignorance of its ultimate cause,

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* In the dog, fibres reach the sphincter by way of both the hypogastric nerves (which are homologous with the presacral nerve) and the inferior mesenteric nerves.[8]

we cannot attack the disease directly, we may still carry out flanking attacks in three directions: (1) we may attempt to diminish the dilatation of the colon; (2) we may try to leave its motor nerves in less disputed control; and (3) we may attempt to relieve any opposition to the expulsion of the content of the bowel offered by the internal sphincter of the anus. If our anatomic and physiologic reasoning is correct, we can accomplish the first and the second objects by division of the inferior mesenteric nerves, and the third by division of the presacral nerve.

Next it must be inquired if these operations can be performed without endangering the functions of any viscera, by interrupting important efferent or afferent fibres. In particular, it is essential to safeguard the afferent fibres from the ampulla of the rectum, so that the mechanism for defecation may be set in motion when fecal matter enters that part of the bowel. In the dog, division of the inferior mesenteric nerves results only in increase in the tonus of the distal part of the colon, and in the patients on whom we performed this operation, the only discernible effect on the colon was the desired one. With regard to the presacral nerve, there is abundant evidence of its functions in man; it is an important afferent path for painful impulses, particularly from the female genitalia and from the bladder; it probably contains inhibitory fibres for the musculature of the bladder, but only rarely, after its section, is transient frequency of micturition observed, and it supplies motor fibres to the internal sphincter of the anus (Case II). The afferent fibres concerned in reflex defecation pass to the spinal cord largely if not entirely by way of the pelvic nerves and the second, third and fourth sacral posterior roots; they are preserved in the suggested operation, which may be performed without fear of producing undesirable results.

In certain cases of obstipation.—When Röntgenograms after a barium meal have given evidence that the fæces reach the distal part of the colon or the rectum in a normal time, it is reasonable to establish the underlying pathologic condition as being in that part of the large bowel. However, the pathologic anatomy in such cases differs from that in Hirschsprung's disease; the rectum may be unduly dilated, but the dilatation is not accompanied by hypertrophy of the muscular coat; indeed, in long-standing cases the muscular coat is actually atrophied. The underlying factor is probably a gradual raising of the threshold of the rectal sensory nerves to the presence of fæces in the ampulla, due to long-continued deliberate neglect to answer the call to defecation. We believe that the operation should be considered in such cases, on the hypothesis that interruption of the inhibitory nerves to the rectum may permit a readier response of the rectal musculature to such reflex stimuli as reach the intramural plexuses.

Technic of operation.—Since the inferior mesenteric artery arises opposite the third lumbar vertebra, and the presacral nerve is to be found in front of the fifth lumbar vertebra, full exposure of these structures may be obtained through a left paramedian incision 15 centimetres long, and centered on the umbilicus. A self-retaining retractor is adjusted, and the table is

tilted to the Trendelenburg position. The small bowel is packed off upward and to the right, so as to expose and pull upward the root of its mesentery; the attachment of the mesentery to the posterior abdominal wall is above the field of the operation, save when the bifurcation of the abdominal aorta is unusually high. An assistant draws the sigmoid colon to the left and slightly downward, to expose the bifurcation of the aorta. In rare cases, the root of the mesosigmoid may be displaced medially, in front of the fifth lumbar vertebra, when it must be mobilized by division of the right leaf of its peritoneum. The promontory of the sacrum is now identified, and in most cases it is possible to see the strands of the presacral nerve as they descend
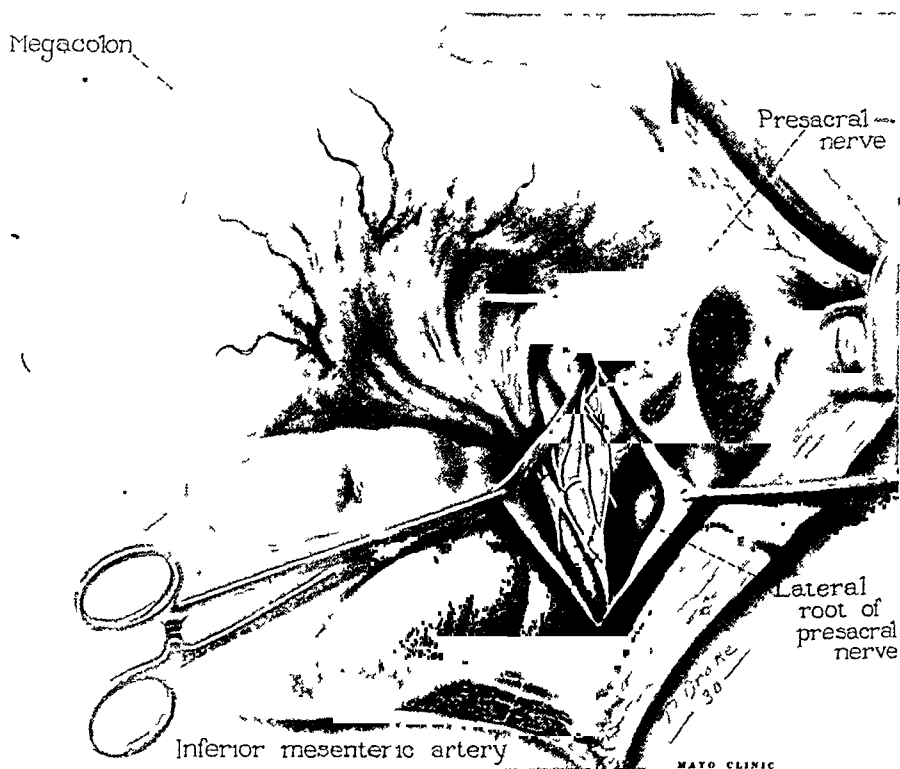
Fig 4 —(Case I)   The field of operation   After division of the presacral nerve, the inferior mesenteric nerves were removed by dividing them at the points indicated

in the middle line, immediately under the peritoneum. The peritoneum is picked up in the middle line, and is incised vertically from the level of the promontory to the origin of the inferior mesenteric artery (Fig. 4). The two edges of this incision are displaced by forceps to each side. The strands of the presacral nerve are not adherent to the membrane, and posteriorly they are separated from the great vessels by a layer of fine connective tissue. The nerve is first divided below, at the right border of the left common iliac vein; it is well to place a ligature on its distal end, as this is usually accompanied by a small artery. It is then raised upward by gentle dissection with cotton pledgets, and the branches which reach it from the fourth lumbar ganglia are divided on each side. Immediately below the bifurcation of the aorta, the connecting branches from the third lumbar ganglia are divided

as they pass to join the nerve from beneath the common iliac arteries. When the nerve has been raised a little higher, its lateral roots, formed by the union of branches from the first and second lumbar ganglia, may be severed; the middle root is preserved if possible, to be used as a guide to the intermesenteric plexus. The trunk of the inferior mesenteric artery is now identified; by tracing upward the middle root of the presacral nerve the operator reaches the two large principal roots of the inferior mesenteric plexus, one on each side of the vessel, and joining it 1.5 centimetres below its origin. If the middle root of the presacral nerve cannot be used as a guide, the main trunks of the inferior mesenteric plexus will be found at the positions of five o'clock and seven o'clock with reference to the origin of the artery. They are large and easily isolated. About 2.5 centimetres of each are then resected; if any ganglionic mass is present on either, it must be included in the resected portion. Any subsidiary periarterial strands are then sought for and, if any are found, they are divided. Bleeding is not to be expected during this part of the operation. The inferior mesenteric vein is too far to the left to appear in the field. The incision in the posterior peritoneum is now brought together with a continuous suture of catgut, and the abdominal wound is closed in the usual manner.

REPORT OF CASES

CASE I.—*Hirschsprung's disease.* A youth, aged seventeen years, came to The Mayo Clinic, August 15, 1929, complaining of constipation, with fecal impaction. He had been constipated since birth, but in the last four or five years fecal impaction had become more frequent, in spite of the use of diets, laxatives, and oil enemas. Examination revealed a hard, freely movable mass of fæces, about 8 centimetres in diameter, to the left of the middle line of the abdomen, and beyond the reach of a finger in the rectum. Röntgenograms after a barium meal gave evidence of an enormously dilated colon, the dilatation extending to the internal sphincter of the anus. Otherwise the findings on examination were essentially negative.

After a period of three weeks, during which the patient was kept on a diet free from residue, had daily instillation enemas of mineral oil, and took mineral oil by mouth three times a day, the colon was emptied of fæces, and laparotomy could be undertaken.

Operation was performed September 3, 1929. The transverse colon, sigmoid colon, and rectum were hugely dilated. The ascending colon and cæcum were less dilated, although there was evidence of the disease in the appendix, which had the girth of a fifth finger. The appendix was removed in the usual way.

The peritoneum over the front of the fifth lumbar vertebra was then opened, and the presacral nerve, in this case single, was easily identified; about 5 centimetres of it were removed. The origin of the inferior mesenteric artery was then exposed by continuing upward the incision in the posterior peritoneum. A number of smaller nerve bundles passing along the artery were first identified and divided. Finally a large nerve bundle was picked up at the position of seven o'clock, and two smaller bundles respectively at five o'clock and ten o'clock. A portion of each strand was resected. The incision in the posterior peritoneum was then closed by a continuous suture of catgut, and the abdominal wound was sutured in layers.

We were sanguine of the success of the operation from the first, as there was entire absence of any gaseous distention of the colon such as might have been expected after operation in such circumstances. Eight days after operation, there was recurrence of fæcal impaction, which yielded to enemas of 50 per cent. peroxide of hydrogen. Three

weeks after operation the bowels were moving well, and all medication was stopped save mineral oil by mouth.

One month after operation the patient was dismissed. He was to take a generous anticonstipation diet, and to use instillations of oil into the rectum, if these should be required. Two months after the operation he wrote to say that he was in excellent health, and that only once since his dismissal had an oil enema been necessary. A month later came a further excellent report: "My bowels move once or twice every day and I take only an ounce of mineral oil about every other day." Seven months after the operation the patient wrote: "I am feeling fine. I have a good appetite, and my bowels move on the average twice a day. I am not taking any medicine, except, occasionally, some mineral oil."

CASE II.—*Rectal type of obstipation.* A waitress, aged twenty-three years, had been under observation for a year, on account of obstinate constipation with episodes resembling acute intestinal obstruction. Three years previously she had had an abdominal operation elsewhere, when a hairpin had been removed from the lower portion of the ileum. Since this operation, she had had increasing difficulty in moving her bowels, and every two or three weeks she had been constipated for two or three days. One year previously she had undergone röntgenologic study of her alimentary tract at The Mayo Clinic, when the following report had been made: "After three hours the stomach contains a little barium. The remainder is in the terminal ileum and in upper loops of the jejunum. After six hours the stomach is empty and almost all the barium is in the cæcum. After twenty-eight hours all the barium is in the right half of the colon. After fifty-four hours the head of the column is in the pelvic colon. There is no slowing in the small bowel, and there is considerable slowing, but no definite point of obstruction, in the large bowel."

A few days after this report had been made, obstruction had occurred again. After six days, during which a little flatus alone had been passed by rectum, great abdominal distention and visible intestinal peristalsis had developed. At operation, performed April 23, 1929, no local cause had been found to account for the obstruction. In spite of this interference a severe degree of constipation had persisted and finally only enemas had procured evacuation of the bowels; even in very large doses purgatives had been ineffectual. Attacks of abdominal distention had been frequent.

January 25, 1930, she came to the clinic on account of a whitlow. It was discovered that her bowels had not been open for thirteen days, although this state of affairs seemed to cause her so little discomfort that at first she was reluctant to undergo any treatment for her obstipation. It was exceedingly difficult to secure an evacuation of the bowel by any means; the lower part of the colon and the rectum lacked sufficient power to expel enemas. The report of a röntgenologic examination of the alimentary canal was as follows: "After twenty-four hours the colon is filled from end to end. The cæcum is already emptying a bit. The size and appearance of the colon is perfectly normal and it is movable. There is only one highly tonic place and that is at the splenic flexure where the size of the colon suddenly narrows. The rectum is full. After forty-eight hours, all the barium is in the descending colon and rectum."

After every medical method of improving the patient's condition had been tried without success, we determined to advise interruption of the sympathetic nerves supplying the distal part of the colon and the rectum. The operation was performed March 11, 1930. Some filmy adhesions between loops of the ileum and the abdominal wall were readily separated. The presacral nerve, which had a plexiform arrangement, was easily isolated and divided in front of the fifth lumbar vertebra. At this stage of the operation, an assistant inserted a finger just within the rectum. When the nerve was first grasped with a hemostat, the internal sphincter was felt to contract. After division of the nerve, stimulation of its peripheral end with a faradic current gave rise to a strong clonic contraction of the sphincter, followed by several weaker clonic con-

tractions. The branches joining the presacral nerve from the third lumbar ganglia were then divided, as were also its lateral roots. The middle root was traced up to the inferior mesenteric artery (Figs. 5 and 6.) One or two branches which passed from ganglia on this root to the inferior mesenteric nerves were first divided, and on carrying the dissection a little higher two trunks were found on the right side forming roots of the inferior mesenteric nerve, a larger at the position of seven o'clock and a smaller at ten o'clock. The inferior mesenteric artery was then mobilized and a large root of the inferior mesenteric nerve was found on the left side at the position of five o'clock. These roots were resected. The incision in the posterior peritoneum was then closed, and the abdominal wound was sutured in layers. Convalescence was uneventful. An

FIG. 5.   FIG. 6.

FIG. 5.—(Case II). Structures removed at operation.
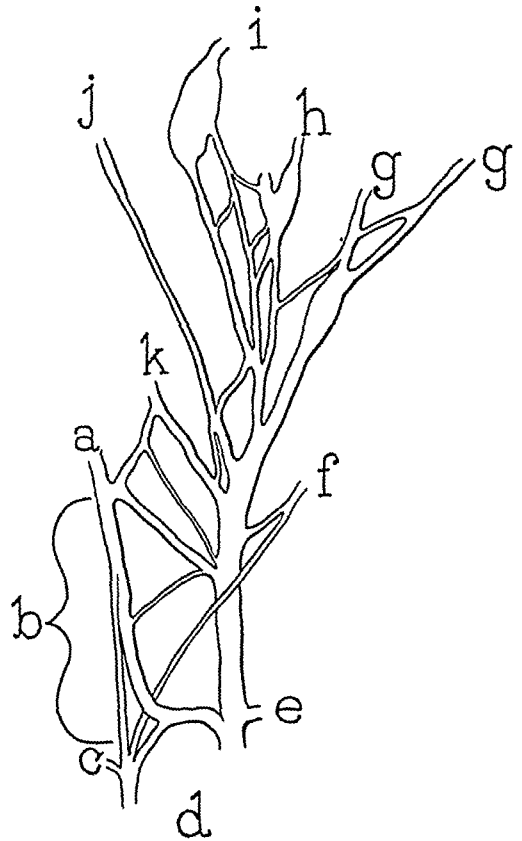
FIG. 6.—(Case II). Drawing of gross specimen shown in Figure 5. The nerves were dissected out after the specimen had been treated with 50 per cent. peroxide of hydrogen; a, right lateral root of presacral nerve; b, vertical extent of presacral nerve; c, branch from right third lumbar ganglion to presacral nerve; d, presacral nerve dividing into hypogastric nerves; e, branch from left third lumbar ganglion to presacral nerve; f, additional branch from left lumbar sympathetic chain to presacral nerve; g, left lateral root of presacral nerve, and h, i, j, k, fibres from intermesenteric plexuses forming middle root of presacral nerve. From the ganglionic masses on h and i branches passed to the inferior mesenteric nerves.

encouraging feature was increased ability to expel the enemas by which the colon was emptied while the patient was confined to bed.

Three weeks after the operation her physician noted: "Clinically, the patient is decidedly improved. She is able to expel enemas with ease, and at intervals has bowel movements of her own volition. I have instructed her to work on a regular program of going to the toilet, attempting evacuation of the bowels, and only using oil instillations if not successful, and water enemas as little as possible."

Six weeks after operation she reported that she was somewhat better; that enemas were still required to secure evacuation of the bowels, but that she was better able to expel them.

COMMENT

The post-operative course of patients suffering from Hirschsprung's disease will be different from that of patients suffering from rectal constipation. This must be emphasized. More immediate benefit is to be expected in the former, for after the operation the hypertrophied musculature of the colon is immediately available for effective peristalsis. It cannot be expected that completely normal defecation will be restored at once, for time will be required for partial or complete readjustment of the organic changes in the colon and rectum to the altered neuromuscular control. Judging from the case we have reported, however, satisfactory defecation begins sufficiently soon to obviate a long course of medical treatment.

In cases of rectal obstipation, not only is hypertrophy of the muscular coat of the bowel absent, but also the long-continued distention of the rectum leads to atony and even atrophy of its musculature. All that can be hoped for is that the rectum will be placed under the most favorable conditions for carrying out its function. A long course of after-treatment will be necessary to reëducate what remains of the rectal musculature, so that it will contract on an appropriate stimulus. As a corollary, it would appear that the operation will be followed by the best results when it is undertaken before profound atony or extensive atrophy has occurred.

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SPLANCHNIC ANÆSTHESIA IN THE TREATMENT OF PARALYTIC ILEUS

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While paralytic ileus may supervene in the course of mechanical ileus, it is generally believed that mechanical factors play a minor rôle in the majority of cases of paralytic ileus. The occasional occurrence of paralytic ileus in kidney colic as well as in other extraperitoneal lesions is ample evidence that the nerve control of the bowel may be a basic factor in the production of paralytic ileus. The essential factors influencing the nerves controlling the bowel which result in paralysis of the bowel are not known, and are probably variable, being purely reflex in some instances and chemical or toxic in others. It is possible that the nerves controlling the motility of the bowel may be affected directly by local inflammatory processes, or by reason of toxins reaching them through the blood-stream.

Markowitz and Campbell[1] have shown that abdominal trauma or chemical irritation of the peritoneum by intraperitoneal injection of weak iodine solution results in cessation of peristaltic waves in the small intestines of animals. Motions of the bowel described by Cannon[2] as segmentation, propulsive waves and swaying or pendulum motion, are dependent on at least three different systems of nerve supply; namely, the enteric, the sympathetic and the parasympathetic. The enteric system, consisting of the plexuses of Meissner and Auerbach, may act independently of the other two as shown by Bayliss and Starling.[3] They showed that intestine isolated from the central nervous system was capable of performance of the characteristic movements. The parasympathetics, or vagus nerves, have an excitatory effect on the muscular activity of the small bowel through the central nervous system. The vagus is therefore essentially motor in its action on the bowel. The splanchnic nerves, or sympathetic system, have an inhibitory effect on intestinal movements and when stimulated cause cessation of intestinal peristalsis.[4] When the splanchnic nerves are paralyzed, marked intestinal movements are noted due to the uninhibited action of the vagus nerves.

The clinical effects of spinal anæsthesia on intestinal movements were first described by Wagner,[5] in 1922, when he reported the occurrence of the evacuation of the bowels after spinal anæsthesia and also noticed active peristalsis of the small intestine during laparotomy performed under spinal anæsthesia. This effect was explained by the paralysis of the inhibitory splanchnic nerves. Wagner then used lumbar anæsthesia in the treatment of paralytic ileus caused by peritonitis in a number of patients, with good results. Following his report there were a number of reports made in

CHART I

Duval's collection of 400 cases of ileus treated by lumbar anesthesia

	Cases	Success	Per cent
1. Strangulated hernia....................................	257	27	10
2. Dynamic ileus...	44	30	38
3. Mechanical ileus.......................................	99	16	16

Dynamic ileus

Spasmodic...	8	8	100
Post-operative...	11	9	90
Ileus without known cause..............................	2	2	100
Ileus in peritonitis....................................	18	10	55
Reflex ileus (renal colic)..............................	1	0	0
Ovarian cyst twisted pedicle...........................	4	1	25

Mechanical ileus

Volvulus...	53	7	13
Bands of adhesions....................................	25	5	20
Carcinoma of colon...................................	17	4	24
Intussusception.......................................	3	0	0
Biliary ileus..	1	0	0

France and Germany on this subject. Duval[6] collected the data on 400 clinical cases of ileus treated by lumbar anæsthesia (see chart). Markowitz and Campbell produced reflex cessation of intestinal motions in dogs by laparotomy, by severe intraperitoneal trauma and by intraperitoneal injection of weak iodine. They were able to reëstablish intestinal movements under these conditions by lumbar anæsthesia and in some instances to demonstrate hyperperistaltic movements.

It is obvious that the best results from increase of peristalsis would be in the different types of paralytic ileus, for it is not reasonable to believe that the mere increase of peristaltic waves would overcome definite mechanical factors. Duval's collected cases bear out this assumption.

In most cases of paralytic ileus, as seen in general peritonitis, the patient is extremely toxic, the blood-pressure is low and the cardiovascular system is at low ebb. To induce lumbar anæsthesia with consequent paralysis of the extremities, as well as to still further lower the blood-pressure, or in some instances to interfere with respiration, is a somewhat heroic procedure. Undoubtedly, with these facts in mind, Rosenstein[7] induced splanchnic paralysis by the injection of weak nicotine solution into the celiac ganglia. He used the posterior route for injection as described by Kappis, and reported some good results in the treatment of paralytic ileus. Ochsner, Gage and Cutling[8] then studied the effect of splanchnic anæsthesia induced by novocaine injected posteriorly into the splanchnic plexus in dogs which had previously had a cessation of intestinal movements by reason of intra-abdominal trauma or by chemical irritation of the peritoneum by weak iodine. They found after splanchnic anæsthesia that intestinal movements were restored and advocated the method for the treatment of paralytic ileus.

The most dreaded and most frequent cause of paralytic ileus is generalized peritonitis. Whether the ileus is due to the absorption of toxins and their effect on the nerves influencing intestinal movements, or whether to paralysis of the bowel from the direct local action of the bacteria, their toxins or the exudate produced, is not definitely known. Sampson Handley[9] has expressed the view that one or more loops of bowels become paralyzed by local action of bacteria and their toxins and that a mechanical ileus develops above the paralyzed area. This may be true in the early stages of peritonitis but is not generally believed to be the fundamental cause of paralytic ileus in peritonitis where relatively early paralysis is the outstanding picture, as contrasted to hyperperistalsis above the point of obstruction in ileus due to mechanical causes. The treatment of the peritonitis is therefore of utmost importance in the prevention and abortion of beginning of paralytic ileus. This means early operation, closure or removal of the source of the peritonitis, quick operation with as little trauma as possible and drainage of the dependent portion of the peritoneum. The stomach must be kept empty by aspiration or Rehfuss tube, the loss of fluids and especially the loss of salt must be replaced by the use of normal salt solution subcutaneously, or by the use of hypertonic salt solution intravenously. Ileostomy has a doubtful position in the picture. Experimentally, Hayden and Orr[10] have not found it of value though there are clinical reports favoring its use. Personally we have had very little help from ileostomy in paralytic ileus in general peritonitis. While all or most of these various procedures have been used without establishment of bowel function, is it advisable to turn to lumbar or splanchnic anæsthesia for help? In the following experiments we have aimed not only to repeat the work on the effect of splanchnic anæsthesia in the reëstablishment of intestinal movements after chemical irritation of the peritoneum, but also after the development of local and general suppurative peritonitis and after chemical peritonitis which has produced a marked plastic exudate, and which, therefore, due to local injury to the bowel, might be a factor in the prevention of normal intestinal movements.

Experimental work.—Moderate-sized, healthy dogs were used. Barium was given in their food for several days preceding the experimental work and in a few instances it was introduced by stomach tube.

Splanchnic anæsthesia was induced by the injection of ½ per cent. novocaine-adrenaline solution by the posterior method of Kappis. Methylene blue was included in the solution in many of the experiments so that at post-mortem it was possible to determine the exact location of the anæsthetic medium injected. After several dissections it was found that at the level of the lower border of the twelfth rib, about three centimetres from the mid-line posteriorly, a needle inserted toward the body of the first lumbar vertebra at an angle of 30° to 35° struck the vertebral body near its anterior surface. The direction of the needle was then changed so that the point slipped over the anterior surface and at that point twenty cubic centimetres of ½ per cent. novocaine-adrenaline solution was injected on each side.

When chemical irritation of the peritoneum was desired, ten cubic centimetres of

equal parts of 2 per cent. solution of iodine and 2 per cent. solution of potassium iodide was injected intraperitoneally (Markowitz and Campbell).

To produce local or general suppurative peritonitis the appendix was ligated and allowed to slough off. In some instances the peritonitis remained local and in others it became general. The experiments on intestinal movements were performed two to four days after ligation of the appendix.

In a few dogs general peritonitis was produced by injection of thirty cubic centimetres of a 50 per cent. glucose solution intraperitoneally, followed in four to six hours by the intraperitoneal injection of a culture of B. coli.

To produce a chemical peritonitis with plastic exudate five cubic centimetres of a 10 per cent. turpentine emulsion was injected intraperitoneally. If, in twenty-four hours, peristalsis was visible by X-ray, another injection was given.

In other dogs a severe sero-hæmorrhagic peritonitis was induced by the injection of forty cubic centimetres of a suspension of B. coli in 2½ per cent. solution of gum of tragacanth in normal salt solution (Steinberg and Goldblatt[11]).

Splanchnic anæsthesia was given only to dogs in which there were no visible peristaltic waves when examined under a fluoroscopic screen.

Experiment 1.—The intestinal motions of normal dogs were studied for several days in order to accustom the dogs to the X-ray room and to remove the possibility of reflex inhibition of intestinal movements. Following splanchnic anæsthesia in these dogs there was a definite increase in intestinal motions in all three dogs. The barium was seen to be vigorously propelled ahead and two of the dogs had several loose bowel movements about one-half hour after the splanchnic anæsthesia.

Experiment 2.—The effect of chemical irritation on intestinal movements. In three dogs weak iodine solution was injected into the peritoneum and upon examination immediately after the injection under the fluoroscope no peristaltic waves were seen. Following splanchnic anæsthesia normal peristaltic waves returned in two dogs within ten minutes and hyperperistalsis developed in the third dog. In control dogs receiving intraperitoneal iodine the peristaltic waves remained absent for at least an hour following the injection.

Experiment 3.—Effect of local peritonitis on intestinal motions. Following ligation of the appendix in four dogs, local peritonitis with plastic exudate around the appendix developed. Peristaltic movements of the intestine were not visible under X-ray. Following splanchnic anæsthesia two dogs had a return of slight peristaltic waves and two had active movements of the small intestine.

Experiment 4.—Effect of plastic peritoneal exudate from the intraperitoneal injection of turpentine emulsion upon intestinal movements. (a) In two dogs receiving intraperitoneal injections of turpentine emulsion practically no plastic exudate was formed although the peritoneum was hyperæmic. There was an absence of visible peristaltic waves when examined under the fluoroscopic screen. Following splanchnic anæsthesia, active peristalsis returned in both animals.

(b) Three dogs developed a slight plastic exudate throughout the peritoneum following the injection of turpentine emulsion intraperitoneally. Peristaltic waves were not visible. Following splanchnic anæsthesia active peristalsis was observed in two dogs and one developed a diarrhœa, but in one animal no peristaltic waves returned.

(c) Eight dogs developed a marked plastic exudate in the peritoneum following the intraperitoneal injection of turpentine emulsion. Intestinal peristalsis was not visible under X-ray. Following splanchnic anæsthesia three dogs showed slight peristalsis, and five dogs had no return of visible peristalsis.

Experiment 5.—Effect of general suppurative peritonitis. (a) One dog developed acute suppurative peritonitis following ligation of the appendix. Intestinal movements were absent as observed under the fluoroscopic screen and following splanchnic anæsthesia no return of peristalsis was seen.

(b) Two dogs developed marked suppurative peritonitis following the injection of hypertonic glucose and B. coli. Peristaltic waves were not visible by X-ray. Following splanchnic anæsthesia slight movements of the small intestine were seen. It is interesting in these experiments to note that practically no plastic exudate was present.

(c) A series of dogs was given intraperitoneal injections of tragacanth and B. coli. A generalized sero-hæmorrhagic peritonitis developed rapidly. The five dogs included in this group had a severe generalized peritonitis at autopsy but were not moribund at the time the experiment was performed. Under the fluoroscope no peristaltic waves were seen in the intestines, and after splanchnic anæsthesia no peristaltic waves, with the exception of one dog, were observed. In one dog very slight intestinal motions returned.

Comment.—While it is thoroughly appreciated that these experiments on dogs cannot be unreservedly applied to the human they nevertheless serve that purpose in a large measure. It is evident that our results on the cessation of intestinal peristalsis following irritation of the peritoneum and their reëstablishment after removal of the inhibitory effects of the splanchnic nerves tally with the work of Markowitz and Campbell as well as with that of Ochsner, Gage and Cutling. When, however, a full-blown peritonitis is established either by bacteria or by a chemical irritant, as turpentine, we have found that the *more severe* and the *more extensive* the peritoneal irritation, and the *more plastic exudate that is laid down*, the *less* likely it is that intestinal movements will be reëstablished by splanchnic anæsthesia. In the most marked instances of general peritonitis, whether the cause be bacterial or chemical, intestinal movements are not demonstrable after splanchnic anæsthesia. This leads one to speculate as to whether the cause of the permanent cessation of intestinal movements as a result of either chemical or bacterial peritonitis is due to the local action of the inflammation affecting the bowel wall and including its nerve supply. Further study of this question is pending.

CONCLUSION

Based on this experimental work the employment of splanchnic anæsthesia to paralyze the inhibitory nerves of the intestine in the treatment of paralytic ileus from peritonitis may be of use in local peritonitis and in the early stages of general peritonitis, but in severe and extensive peritonitis little or no aid in the reëstablishment of intestinal movements is to be expected.

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DISCUSSION: DR. D. E. ROBERTSON, of Toronto, remarked that it is over thirty years since Treves resected a megalocolon. Lane subsequently carried out the same treatment. The operation was very severe and the mortality high. In those cases that did survive the operation, the results were not such that would lead surgeons generally to undertake the proceeding. Royle noted in his first rami-section the patient was cured of constipation. Wade and he together reported five cases, two of which were cured. Fraser told me in 1926 that he was able to cure megalocolon by dividing the sympathetic nerves in the mesentery of the large intestine.

Royle's operation of rami-section is the easiest proceeding and the one that will give results in the cases of megalocolon. The operation is easy, much the simplest procedure that has been described in attacking the nerves that have to do with the sympathetic innervation of the large intestine. It is much more simple than the proceeding of opening an abdomen and hunting for the nerves after packing back the intestines. The flank operation allows one to extraperitoneally divide the fibres which go to control the sympathetic nerve supply of the intestine. He then showed lantern slides of two cases, both girls of nine years of age. They are both clinically cured. One I operated on in September, 1927. The first slide was taken in 1927, prior to operation, shows a very large megalocolon. The next slide, taken two years later following a rami-section of the mesial branches going from the left trunk, shows spontaneous movements the day following operation. Within two weeks she was averaging between five and ten movements a week. In the two years that have elapsed since her operation she required practically no help to secure bowel movements. One slide shows a barium enema taken two years after operation. Here will be seen that the colon, which formerly was of enormous dimensions, is now small and shows haustrations. The colon is, in reality, smaller than normal.

In the second patient before her operation the colon had a tremendous capacity. Following her operation of rami-section she had spontaneous movements. These movements were, in the first two weeks, daily. Following this movements became more frequent. She would have seven to twelve movements a week. This situation persisted until six months after operation when she returned to hospital complaining that she was having desire for movement and would go to stool three or four times a day and would pass small quantities only. Examining her abdomen at this time there was a palpable mass which could be indented. She was taken into hospital and with six enemas in three hours the large gut was evacuated and eight days later a slide taken after a barium enema showed the colon very small. The haustra are well marked.

His purpose in speaking was to call attention to the very practical operation of Royle. There is no operation that is as simple or has greater ability to give results. By its use one altogether eliminates the possibility of abdominal complications and sequelæ. Surgery as a whole owes a great

debt of gratitude to Dr. Royle for his very interesting and practical observations in regard to large gut function and sympathetic control.

Dr. W. J. M. Scott, of Rochester, New York, had felt that there was one other important step to be made in these cases, namely, to predetermine before operation if possible what effect we would get by removal of the sympathetic influence. He had studied in this way two cases of this disease. The first case was a typical example of Hirschsprung's disease in a seven year old boy. The motor activity of the bowel was studied with barium enemas. After a month of medical treatment, the large bowel still easily held four quarts of barium solution without discomfort or any sensation of fullness. His maximum effort only resulted in the evacuation of a small amount, not over a quart of the enema. Within five minutes, spinal anæsthesia was followed by an involuntary evacuation. This, assisted by his voluntary effort, resulted in the expulsion of three fourths of the enema within the next twenty minutes. Four hours after the spinal anæsthesia he had expelled all of the enema except a small amount in the recto-sigmoid. This was fairly conclusive proof that removal of the sympathetic innervation would benefit this boy and consequently he took out both lumbar sympathetic chains. Three weeks after operation he began to have regular spontaneous bowel movements for the first time in his life. The motor function of the colon was investigated again about two months after his operation. The first noteworthy change was that now two quarts of barium caused him discomfort and he had great trouble in retaining it. When asked to expel what he could, he evacuated all of the enema.

He had recently used this method in a case of very severe constipation in an adult. The test shows its value particularly well in the latter case. This patient had very severe constipation. A barium enema given, remained *in situ* for seven days, until the physician taking care of her feared obstruction would result and finally by repeated washing succeeded in emptying the bowel. Later the barium enema was repeated, spinal anæsthesia was given, and the patient was able to evacuate only a little of the barium from the rectal ampulla. The motor activity of the large bowel was not greatly augmented under spinal anæsthesia. The patient was saved an ineffective sympathectomy by the application of this test.

ILEOCÆCAL OBSTRUCTION ASSOCIATED WITH APPENDICITIS

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The remote results of operations performed for chronic appendicitis show conclusively that a fairly large number of patients do not secure the relief of symptoms for which the operation was performed. While it is not possible, at this time, to enter into a review of all the pathological conditions which may follow or be associated with appendicitis in its acute or so-called chronic form, we desire to call attention to a lesion which is met with, not infrequently, in abdominal explorations for appendicitis; namely, ileocæcal obstruction. We believe that a certain proportion of the unfavorable results are due to a failure to recognize this type of obstruction. Our attention was directed first to the lesion in secondary operations undertaken for the relief of symptoms after appendectomy had been performed. As we have found the obstruction to be not uncommon and to be associated with chronic appendicitis, we believe that the exploration should include among other parts to be reviewed, the routine examination of the ileocæcal region and the patency of its valve.

Proof of the above statement as to the unsatisfactory results obtained in operations for chronic appendicitis is to be found in a review of a series of cases previously reported. Thus, Gibson,[1] in 1920, in a follow-up study of 555 cases of chronic appendicitis, of which 426 were heard from, found excellent results had been obtained in 259 cases; satisfactory results, that is, relief of the former condition but still having some minor symptoms, in sixty-five cases. The most frequent complaints were constipation, indigestion, and backache. In 102 cases the relief was not satisfactory, as in this group the pain persisted after the operation and was of four types: (1) vague symptoms, seen mostly in women (twenty-one cases); (2) pain in the appendiceal region (twenty cases); (3) same pain as before operation (twenty cases); and (4) pain in the epigastrium (seven cases). Gibson concluded that a more detailed pre-operative study and thorough exploration were necessary to obtain better results. He advocated a large incision, and even though the appendix is frankly infected, in the absence of contraindications, a thorough abdominal exploration should be made.

Deaver and Ravdin,[2] in 1923, reported the end-results in 500 cases operated upon for chronic appendicitis. Of the 226 patients traced, 188 were entirely relieved of symptoms, twenty-two partially relieved, and sixteen were unimproved. The figures indicating that 83.1 per cent. were relieved, 9.7 per cent. partially relieved, and 7.9 per cent. obtaining no relief, led the authors to conclude that a failure to obtain any relief was due to faulty pre-operative study and exploration.

Holder and Menninger,[3] in 1926, reported a follow-up study of 208 cases of chronic appendicitis. Approximately one-half of the patients were heard from and of this group, eighty-one, or 77.1 per cent., had complete relief. A study was made of twenty-two cases in which there were no pathological findings in the appendix, but mechanical factors occurred in the vicinity of the appendix. In this group, twenty, or 91 per cent., were relieved and two, or 9 per cent., experienced no relief.

Davis,[4] in 1927, reported the results on 677 patients operated upon for chronic appendicitis. Following Gibson's grouping he found there were 221 excellent results, eighty-nine were satisfactory and 110, or 26 per cent., were unsatisfactory.

To summarize the end results of these several studies it can be concluded that 18 to 26 per cent. of the patients operated upon for chronic appendicitis are not completely relieved of their symptoms.

Most articles written upon disturbances of the ileocæcal valve as a cause of ileal stasis and attacks of pain, constipation, etc., state that the stasis and its resultant symptoms are due to incompetency of the valve. No mention is made of obstruction of the valve playing any part in such cases. The only suggestion that the lesion is obstructive in character was made by Case[5] in his X-ray studies of ileal stasis when he named spasm of the ileocæcal valve as one of the three causes of that condition. The ileocæcal valve serves a similar function between the middle and hind gut as the pyloric muscle does between the fore and middle gut. Innumerable studies and contributions have been made upon pyloric obstruction but, so far as we know, nothing has been written upon the incompetency of the pyloric ring. In the light of our experience with the cases we wish to present, this difference was all the more amazing, as it seems logical to us that we should have obstruction of the ileocæcal valve as we have pyloric obstruction, and the results obtained in our cases and the similarity in function of the ileocæcal value to the pylorus suggests a greater consideration of the existence of ileocecal obstruction as an entity than has been given to it in the past.

Case, in 1913, made a very thorough röntgenological study of ileal stasis and suggested three causes: (1) adhesions to the terminal ileum; (2) ileocæcal sphincter spasm, first noted by Hertz in 1908; (3) incompetency of the ileocæcal valve. In more than fifty patients, Case definitely demonstrated regurgitation of the ingested bismuth from the colon into the small intestine. In every case of incompetency of the valve, gas or fluid distention of the terminal ileum was found at the operation. He suggested the following method to test the competency of the ileocæcal valve at the time of operation. The ileum is clamped by the fingers of the assistant twelve to fifteen inches from the valve and its contents milked into the cæcum. The normal ileocæcal valve prevents any regurgitation of the cæcal gas or fluid content into the ileum, even under considerable pressure. The incompetent valve, however, allows gas or fluid to pass back readily, varying with the degree of incompetency. In a study of 138 cases of ileal stasis Wallace[6] concluded that incompetency of the valve was the dominant cause as he cured cases of ileal stasis by repair of the valve in instances in which the adhesions were not disturbed. After an extensive experience Kellog[7] described a method of repairing an incompetent valve and another method of constructing an artificial

ileocæcal valve. He found that an efficient valve could be constructed by simple intussusception of the ileum into the large intestine. Such a valve worked perfectly, as it was impossible to inflate the colon through the ileum and distend it with considerable force without the occurrence of the slightest reflux. The construction of the new valve is indicated in cases in which the valve may be destroyed by disease or is necessarily sacrificed by surgical measures.

A brief consideration of the normal functions and the anatomical structure of the ileocæcal valve is necessary before discussing our group of cases of ileocæcal obstruction. Kellog has summarized the functions concisely as follows:

"Bauhim, Tulpius, and others of the early anatomists showed that the ileocæcal valve is a most efficient mechanical contrivance for preventing reflux of gas or liquid content from the colon into the small intestine. John Mason Good observed that, in addition to its mechanical structure, the ileocæcal valve possesses also a muscular function capable of acting as a sphincter. Elliott demonstrated, in 1904, that the valve behaves as a true sphincter in the dog, possessing like the pylorus a special nervous mechanism distinct from other parts of the alimentary canal. Sir William Macewen recorded the results of observations made upon a case in which, as the result of the destruction of a portion of the anterior wall of the cæcum, it was possible to observe the action of the ileocæcal valve and a reciprocal activity of the appendix.

"Case, Cannon, and others who have made a systematic study of the alimentary canal by the aid of the X-ray have demonstrated that the ileocæcal valve not only prevents reflux of material from the colon into the small intestine, but also regulates the movement of material from the small intestine into the colon in a manner quite analogous to the action of the pylorus in passing digesting food from the stomach into the small intestine.

"That these functions of the ileocæcal valve must be highly important to the welfare of the body is a necessary inference from the fact that the structure is present in practically all vertebrate animals above the level of the amphioxus. The pylorus and the ileocæcal valve divide the alimentary canal into three parts, the functions of which differ in such a way as to require their isolation. These are known to anatomists as the fore-gut, reaching from the mouth to the pylorus; the mid-gut, including the small intestine, and extending from the pylorus to the ileocæcal valve, and the end-gut, or the large intestine. When, as a result of disease, reflux from the small intestine into the stomach occurs, the result is nausea, vomiting and serious interference with the functions of the stomach."

Cunningham[8] gives the following excellent description of the ileocæcal valve as found in human beings:

"Where the ileum enters the large intestine, the end of the small gut is, as it were, thrust through the wall of the large bowel, carrying with it certain layers of that wall, which project into the cæcum in the form of two folds, lying respectively above and below its orifice, and constituting the two segments of the ileocæcal valve. The conditions may be compared to a partial inversion or telescoping of the small into the large intestine; it must be added that the peritoneum and longitudinal muscular fibres of the bowel take no part in this infolding; on the contrary, they are stretched tightly across the crease produced on the exterior by the inversion, and thus serve to preserve the fold and the formation of the valve.

ILEOCÆCAL OBSTRUCTION WITH APPENDICITIS

"As seen from the interior, in the specimens which have been distended and dried, the valve is made up of two crescentic segments—an upper, in a more or less horizontal plane, forming the superior margin of the aperture, and a lower, which is also larger, placed in an oblique plane, and sloping upward and inward (*i.e.*, toward the cavity of the cæcum). Between the two segments is situated the slit-shaped opening, which runs in an almost anteroposterior direction, with a rounded anterior and a pointed posterior extremity. At each end of the orifice the two segments of the valve meet, unite, and are then prolonged around the wall of the cavity as two prominent folds—the frenula (frenula valvulæ coli). It is thought that when the cæcum is distended, and its circumference thereby increased, these frenula are put on the stretch, and pulling upon the two segments of the valve, they bring them into apposition, and effect the closure of the orifice.

"In bodies hardened *in situ* with formalin, the valve and orifice present an entirely different appearance, suggesting, much more closely than in the dried state, the appearance of telescoping or inversion mentioned above. In them, also, the two segments of the valve are much thicker and shorter, but they can always be distinguished, and are found to bear the same relation to one another as in the dried condition, although this may be obscured by foldings or rugæ. The aperture may be slit-like or rounded, with sloping or infundibuliform edges; the frenula are not so prominent at times; but the whole valve projects much more abruptly into the cavity of the cæcum than in the distended and dry specimen.

"Each segment of the valve is formed by an infolding of all the coats of the gut, except the peritoneum and the longitudinal muscular fibres, and consequently it consists of two layers of mucous membrane, with the submucosa and the circular muscular fibres between, all of which are continuous with those of the ileum on the one hand and of the large intestine on the other. The surface of each segment turned toward the small intestine is covered with villi, and conforms in the structure of the mucous membrane to that of the ileum; while the mucous membrane of the opposite side resembles the mucous coat of the large bowel.

"In the dried specimen the upper segment projects further into the cavity of the cæcum than the lower, so that the aperture appears to be placed between the edge of the lower segment and the under surface of the upper.

"There is little doubt, as pointed out by Symington, that the efficiency of the ileocecal valve is largely due to the oblique manner in which the ileum enters or invaginates the cæcum; this oblique passage alone, as in the case of the ureter piercing the wall of the bladder, would probably be sufficient to prevent a return of the cæcal contents. In the great majority of cases, when in position within the body, the ileum is perfectly protected from such a return, although when the parts are removed, and then distended with fluid, this often passes through the valve and reaches the small intestine. Still, the efficiency of such a test, applied when the parts are deprived of their natural supports, cannot be relied upon.

We have used the term "ileocæcal obstruction" to include two types of cases: (1) actual obstruction of the valve produced by adhesions, causing invagination or angulation of the ileum directly at the valve; and (2) a disturbance in the motility of the terminal ileum produced by adhesions binding it to the lateral or posterior abdominal wall. In some cases the long-standing irritation occurring in chronic appendicitis probably produces the adhesions leading to obstruction either directly at the valve or in the terminal portion of the ileum. While we are interested chiefly in the cases of valvular obstruc-

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tion, the lesions of the terminal ileum, due to kinking caused by adhesions (Lane[9]), are included as we have used free omental transplants in the treatment of both conditions.

The most constant and characteristic complaints, in addition to the usual symptoms of appendicitis, were constipation and flatulency. While the degree of constipation varied, with but few exceptions, all patients had to take cathartics. Apparently, the narrowing of the ileocæcal opening by preventing the intestinal contents from readily entering the cæcum, has been responsible

Fig. 1.—X-ray showing narrowing of ileum at the ileocæcal junction.

for the flatulency and, to some extent, for the development of constipation. Toxic symptoms, particularly headaches, were noted when constipation was of long duration. As similar symptoms occur in cases of visceroptosis with a low-lying mobile cæcum, the differential diagnosis from this condition is most difficult at times.

A gastro-intestinal study by means of the X-ray may reveal the ileocæcal narrowing and partial obstruction, as is shown in Fig. 1, although this finding is not constant and a positive diagnosis is not always possible by this means. In the event of negative X-ray findings, it has been our practice to recommend exploratory operation after a reasonable trial has been given to dietary and other measures carried out by the internist.

When the ileocæcal region is inspected in many of these cases, the serosa is apparently normal. If an attempt is made to introduce a finger through the valve, by invaginating the ileum, the opening is found narrowed and at times cannot be demonstrated because of the dense adhesions and the degree of thickening of the ileum. (Fig. 2.) The adhesions at the junction of the terminal ileum with the cæcum were found without exception in the portion of the bowel adjacent to the posterior lip of the valve, as noted in Fig. 3. In several of the cases with marked constriction the adhesions extended around the bowel and involved the anterior lip. A positive diagnosis of valvular obstruction should not be made until attempts to introduce the tip of the exploring finger through the opening have been tried at several angles, as there are many variations of the angle at which the ileum enters the cæcum.

By means of careful dissection, the ileum can be released from the cæcum and gradually the opening will become apparent and the tip of the exploring finger can be passed through the valve. One-half to two centimetres of the bowel may be separated by this means before a sufficient degree of patency is obtained. (Fig. 4.) When the outer coat of the cæcum is reached, a definite change in texture is observed: the tissue is firmer, does not separate as readily as do the adhesions, and this is an indication that further dissection may be dangerous by injuring the valve.

point of obstruction
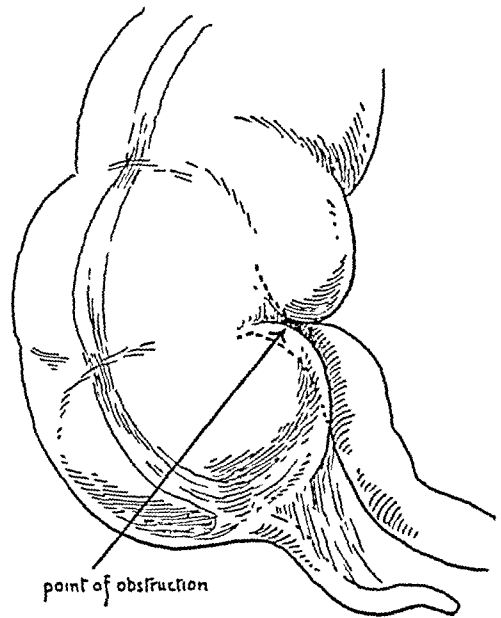
Fig. 2.—A diagrammatic representation of invagination of ileum producing ileocæcal obstruction.

Thickening of the wall of the terminal ileum is frequently seen and this may be so pronounced that the bowel feels like and resembles the structure of the jejunum. The cause of the hypertrophy may be explained by the fact that extra work is thrown upon this portion of the ileum in an effort to force the bowel contents through the obstructed ileocæcal valve. In this connection the observation of Keith may be of importance, for he believes that the musculature of the terminal portion of the ileum, four inches above the valve, is endowed with a special tonic function whereby it serves as a sphincter for the terminal portion of the ileum.

After examination of the ileocæcal valve the terminal ileum is explored and an attempt is made to deliver it from the abdomen. If adhesions are present, binding the bowel to the lateral abdominal wall, the angulation of the bowel is noted, and, if of minor degree, the bands are not disturbed.

In the more pronounced cases, in which surgical interference is indicated, the bowel is firmly bound by adhesions to the lateral wall, cannot be delivered, and may be angulated. The hypertrophy of the terminal portion of the

FIG. 5.—Omental graft sutured over defect.

Omental graft.

FIG. 4.—Serosal defect produced by freeing of adhesions.

Denuded areas
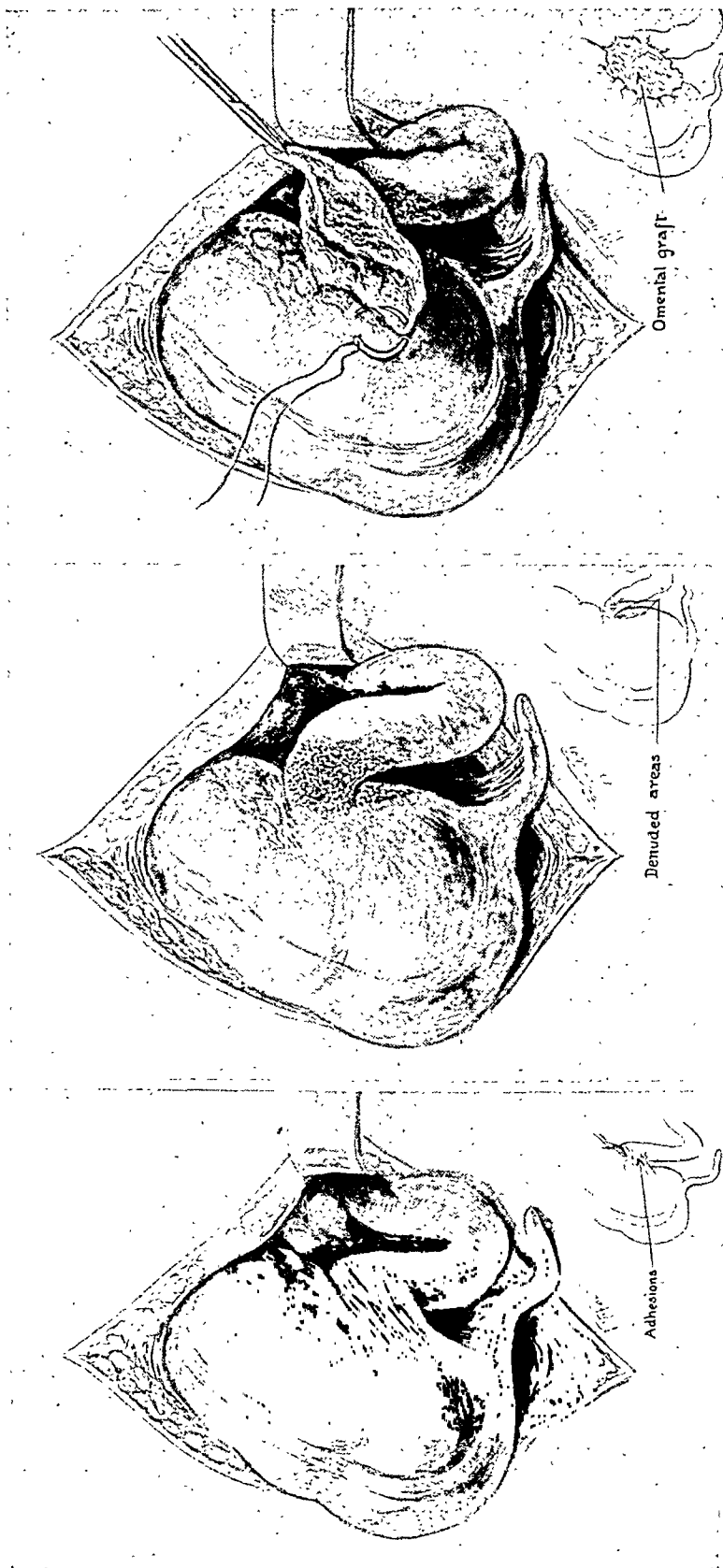
FIG. 3.—Valvular type of obstruction showing adhesions.

Adhesions

small bowel is most pronounced in these cases. MacKinley,[10] in noting the hypertrophic changes in the bowel wall in this type of case, states that ileal kinks are caused by the cicatrization of the lower leaf of the mesentery of the ileum, as a result of recurrent attacks of appendicitis, and thinks that this cicatrization interferes with the return of blood through the colic vessels supplying the ileocecal region and produces a chronic congestion in the walls of the distal portion of the ileum. This congestion, persisting over a period of time, causes a hypertrophy of the tissues of the ileum. The anastomosis of the ileocolic with the right colic enables the venous blood of the first portion of the colon to escape without causing congestion and hypertrophy of the first portion of the colon.

After the release of the adhesions, the bowel can be delivered into the wound, is freely movable and the angulation is entirely overcome. The resulting serosal defect in both the above conditions is then covered by a free omental graft. (Fig. 5.) A thin and well-vascularized portion of the greater omentum is used as we have found this the most satisfactory type of graft. The transplant is carefully sutured over the serosal defect, using many sutures to obtain good approximation, as adhesions to the edge of the graft occur less frequently when this precaution is observed. The raw edge of the greater omentum, from which the graft is taken, is buried between the two layers of the omentum to prevent it from becoming adherent to the graft or other abdominal viscera.

The following case histories are abstracted briefly in order to illustrate the commonest types of pathologic lesions encountered, the symptoms they produced, and the means employed to correct the condition.

CASE I.—V. A., a male, forty-three years of age, was admitted to the Presbyterian Hospital with the chief complaint of pain in the abdomen. For the past two years the patient has suffered from flatulency, for which frequent cathartics were taken. Following the catharsis he experienced pain in the lower right quadrant of the abdomen. For the first few months of his illness the pain was nothing more than a dull ache and lasted approximately twenty-four hours. Subsequently the atttacks increased in frequency, length of duration, and the pain was more severe. A week before admission, he experienced an attack which continued four days and the pain was very sharp and intermittent. Appetite has been poor because of the tendency to gas formation and constipation. During the past two years he has had many dull headaches which have also increased in frequency and severity. Upon physical examination, the abdomen was slightly distended and there was moderate tenderness, but no rigidity over McBurney's point. Urine analysis was negative, and a fractional gastric analysis showed a normal curve. An exploratory operation performed through a lower right rectus incision disclosed a partially obliterated appendix which was moderately inflamed. Upon examination of the ileocæcal junction, the terminal ileum was found to be adherent to the cæcum and so fixed by dense adhesions, that the valve would not admit the tip of the little finger. The adhesions were dissected at the ileocæcal junction separating one and one-half centimetres of the posterior portion of the terminal ileum. Following the liberation of these adhesions the valve could be entered easily with the index finger. The resulting serosal defect was covered with a free omental transplant. The patient made an uneventful recovery and two years after operation, reports that the headaches have disappeared, constipation has been completely relieved, and the use of cathartics

has been discontinued after being used continuously for many years. This case illustrates the most typical form of ileocæcal obstruction accompanied by toxic symptoms and attacks of pain. The degree of obstruction found at the operation readily explained the cause of the attacks of intermittent sharp pains in the right lower quadrant of the abdomen following catharsis. We believe the ileocæcal obstruction was the source of the patient's symptoms, and relief would not have been obtained by simple appendectomy.

CASE II.—P. M., a male, fifty years of age, was admitted to the Presbyterian Hospital with a chief complaint of pain in the right lower quadrant, and constipation which had become more pronounced during the past two months. Six weeks before admission he developed a dull, intermittent pain which did not radiate and was not accompanied by nausea and vomiting. The attack lasted forty-eight hours and since that time he has suffered from a dull ache and considerable abdominal distention. Upon examination of the abdomen, no tenderness or rigidity were found and no masses were palpable. A fractional gastric analysis showed an absence of free hydrochloric acid; the highest total acidity was 22. Urine analysis was negative. An exploratory operation was performed, and an inflamed appendix, which was kinked and doubled upon itself, was found in the retrocæcal space and removed. The ileocæcal valve was found to be normal; however, there was definite kinking of the ileum about four inches from its termination, due to adhesions binding it down to the lateral wall. The adhesions were severed, the kink relieved, and the resulting serosal defect was covered with a free omental graft. The transverse colon was found to be adherent over the anterior surface of the ascending colon just above the cæcum producing a definite angulation at the hepatic flexure. These adhesions were freed and the raw surfaces oversewn. The patient was discharged from the hospital fourteen days after operation, relieved of his acute symptoms. His bowels have moved regularly and there has been no recurrence of symptoms, two years after the operation.

This case is presented as an example of a disturbance of the motility of the terminal ileum, caused by adhesions binding this portion of the bowel to the lateral wall; there was no apparent obstruction in the ileocæcal valve.

Twenty-three cases have been operated upon during the past two years and the condition was found most frequently in the third and fourth decades of life. The duration of symptoms varied from a few months to twenty years; in nine patients symptoms were present less than one year, six from one to three years, and two were of twenty years' duration. A history of constipation with the use of cathartics was noted in seventeen cases, gas pains accompanied the constipation in nine cases, and toxic symptoms were noted in four instances. The more severe cases with pronounced constipation had the valvular type of obstruction. The character of the pain was not constant; in nine patients it consisted of a dull ache which was present more or less all the time. Fourteen patients experienced attacks of pain sufficiently severe to be considered as acute appendicitis. Of the twenty-three cases studied, thirteen had the valvular type of obstruction, and in ten there was kinking of the terminal ileum. Twelve of the thirteen patients having valvular obstruction suffered from constipation and gas pains, whereas only seven of the ten patients with kinking of the terminal ileum had these complaints. This is about what is to be expected when the difference in the narrowing of the lumen of the bowel is considered in the two conditions. It is also of interest to note that twelve of the thirteen patients with valvular

obstruction had severe attacks of pain, whereas the pain was severe in only five of ten cases with adhesions to the terminal ileum. Three cases had previous appendectomies without symptomatic relief. At the second operation a kink was found in the terminal ileum in one patient, and two had pronounced valvular obstruction. In all three instances there was severe constipation accompanied by gas pains and toxic symptoms. In one case there was no improvement; in the second case the constipation was greatly improved and toxic symptoms disappeared; and in the third case slight constipation persisted but complete relief of pain and toxicity was obtained. Free omental transplants were used in eighteen cases; in five instances the resulting serosal defect was small, and could be covered by suturing. Our follow-up study upon these patients was most encouraging. Of the twenty-three cases, twenty were heard from, and in fourteen there was complete relief of the constipation, gas pains and toxic symptoms. In two patients the constipation was partially relieved and there was complete relief of other symptoms. In two cases there was improvement in the degree of constipation and relief of other symptoms, but the patients have been operated upon so recently they cannot be classified as cures. In two patients there was no relief of the constipation but there was complete relief from the attacks of pain.

CONCLUSIONS

1. Routine exploration in chronic appendicitis, and in acute appendicitis when justifiable, should include an examination to determine the patency of the ileocæcal valve.

2. A certain proportion of the poor remote results in operations for chronic appendicitis may be attributed to failure to note ileocæcal obstruction and to properly relieve it.

3. Relief obtained by freeing adhesions followed by the use of omental transplants has afforded sufficiently favorable results in overcoming the obstruction to justify the employment of this procedure.

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DISCUSSION: DR. HUBERT A. ROYSTER, of Raleigh, N. C., called attention to the importance of the associated conditions around the ileocæcal region in the consideration of apppendicitis, both of the acute and the recurrent types. For many years surgeons failed or rather declined to pay very much attention to the so-called kinks or other forms of adhesions and as the result the patients came back with secondary symptoms. Now all examine the region and pay attention to these several kinks, but this question of ileocæcal obstruction brought up by the authors is of equal importance. Curiously enough, some years ago he stumbled on the question by accident in pulling out the ileum as far as it would go and found it folded upon itself in two cases like an accordion. In both those cases he did the same thing as the authors have suggested, found that he had a raw surface and did an omental graft. Following this up he made it a point to use this same method of drawing the ileum and the cæcum away from each other.

Dr. Speese in closing said:

I was perfectly aware that attention has been called many times to the intrinsic incompetency of the ileocæcal valve. That is not a new subject, but there is an extrinsic obstructive incompetency which sometimes exists without any incompetence of the valve itself. The Bauhin valve is not a circular or constricting area but a slit-like opening which perhaps performs its function like the mouth of a fish, so that there is no particular reason why we should have a circular obstruction as we do in ulceration at the pylorus. The important point is that when one gets through the operation of removing the appendix to determine positively whether the ileum enters the cæcum at a right angle. If it does not, then attention should be paid to this region by pulling them apart.

In conclusion he mentioned a very important anatomical matter which was first pointed out to him by Payne, of Norfolk, Virginia. He made the observation that the vessels of the terminal ileum, that is within three to four inches of the cæcum, run parallel with the axis of the bowel and not transverse as in the rest of the small intestine. So that one knows that one has approached the end of the ileum, the very end, when one observes the vessels for two to three inches running toward the cæcum instead of around the bowel.

DIVERTICULA OF THE SIGMOID

By William J. Mayo, M.D.

of Rochester, Minnesota

My interest in diverticula of the intestinal tract was first aroused by the classical contribution of Reginald Fitz in 1888, on diverticula of the intestine, although this paper was devoted largely to diverticula of the Meckel type.

Diverticula of the colon were first described by Cruveilhier, in 1849. In 1857, Habershon, a physician, published the first account of diverticulitis in English. In 1858, Sidney Jones reported a striking case of acute diverticulitis which resulted in a fistulous connection between the bladder and the sigmoid. However, attention was not generally attracted to diverticulitis of the sigmoid until 1889, when Graser of Erlangen emphasized the frequency and significance of the disease. The first comprehensive treatise embodying both etiology and classification was brought out by Edwin Beer in 1904. This has been followed by papers by Telling, Drummond, Mummery, Hartwell, Brewer, Rogers, Mailer, and others. In 1907, Moynihan's classical paper on its mimicry of carcinoma of the colon appeared, and this deservedly received much attention. In 1907, Wilson, Giffin, and I reported five cases in which a portion of the sigmoid was excised for obstructive diverticulitis with the formation of tumor; these were the first instances recorded in which an actual demonstration of the pathologic change in diverticulitis was made during the life of the patient.

There are two types of diverticula of the colon, the true and the acquired. In true diverticula of the congenital, traction, or pulsion types, all the intestinal coats cover the sac. In diverticula of the acquired type, the mucous membrane of the intestine pouches through small openings in the musculature at weak points in the wall of the colon, such as holes for vessels or defects of muscle. Such diverticula often contain small hardened fecal masses. The sigmoid nearly always is involved in diverticulosis. If the entire colon is affected, there usually is a gradual increase in the frequency of the diverticula from right to left. The diagnosis of diverticulosis now rests securely on radiographic evidence.

Records at the clinic show a total of 2,139 cases of diverticulosis. Robertson's observations on our post-mortem service show that 5+ per cent. of persons more than forty years of age have diverticulosis, and his data approximate as to frequency those based on X-ray evidence. Thus, in the period from 1924 to April 1, 1930, inclusive, 31,838 X-ray examinations of the colon were made for general diagnostic purposes, and in 1,819 of these (5.71 per cent.) diverticula were present. Only twenty of these 1,819 patients were less than forty years of age. Of our 2,139 recorded cases of diverticulosis, active diverticulitis was present in 696 at the time the patients

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were examined. Inasmuch as in the earlier period, prior to 1916, only the cases of diverticulitis were recognized and properly recorded, these figures are of little value in establishing the frequency with which diverticulosis gives rise to diverticulitis. Statistics of the later period give 12+ per cent. of cases of diverticulosis resulting in diverticulitis, but for obvious reasons this is probably an overestimate. A study of the relative incidence of diverticulosis in men and women in this group of cases showed that 64 per cent. of the patients were men; 36 per cent. were women. As constipation is more common in women, these figures would seem to show that it is not an important factor in the causation of diverticulosis. Nor can much significance be attached to obesity as an etiologic factor, inasmuch as the percentage of patients who were underweight was about the same as that of those who were overweight.

CLINICAL FEATURES.—With rare exceptions, the type of inflammation of diverticula which we speak of as diverticulitis is confined to the sigmoid. The inflammatory condition usually is limited to one or several diverticula, but a considerable length of the bowel may be obstructed and greatly thickened from œdema and adhesive inflammation; thus a well-marked tumor in the lower part of the abdomen to the left of the median line often, if not usually, forms during the acute stage. Cases of the disease may be classified clinically into four groups.

Group 1. Self-limiting diverticulitis and peridiverticulitis.—The symptoms of acute diverticulitis are pain in the region of the mass, which often is palpable, a moderate degree of fever, and gaseous distention. As a rule these symptoms are not severe, and, although the temperature may be elevated one or two degrees, the patients are often ambulatory after the first day or two, and the tumor usually disappears in the course of a few weeks.

Group 2. Diverticulitis and peridiverticulitis with formation of abscess resulting in entero-intestinal, enterovesical, enterocutaneous, and other fistulæ.—This group includes those cases in which infections (either localized peritonitis with formation of abscess, or the results of infectious processes which connect the diseased sigmoid with the neighboring intestine, the bladder, or the skin) lead to the necessity for surgical interference. Rarely, an infected diverticulum in the terminal portion of the sigmoid may be the cause of an abscess resulting in an intractable fistula in the posterior anal region, as pointed out by C. H. Mayo.

Group 3. Diverticulitis complicated by obstruction of the bowel.—In acute diverticulitis the obstruction is the result of infection and œdema. Chronic obstruction is due to hyperplasia, adhesions, and angulation (the hyperplastic stenosing type). The conditions are practically identical with those in Groups 1 and 2, but the additional factor of obstruction in these cases is so serious a feature that it seems best to classify them independently. It is surprising, however, when the entire mass is dissected out and the diseased bowel laid open, to find so little actual obliteration of the lumen of

the bowel, and, unlike cases of carcinoma of the sigmoid, the obstruction is rarely complete.

Group 4. Carcinoma developing on a diverticulum.—This group is of great interest. In rare cases the carcinoma may have such a definite relationship to the diverticulitis as to make it reasonable to assume that infection and irritation by hardened fecal masses in diverticula might have been the cause of chronic irritation and pre-cancerous change. Until recently, the only known fact of significance in the etiology of carcinoma was its relation to chronic irritation. Today the question of individual susceptibility to carcinoma is beginning to attract scientific attention. The term "pre-cancerous" is used to denote certain cell changes taking place in areas of chronic irritation, which would be typical of carcinoma if found in connection with invasion of the tissues.

It has often been pointed out that carcinoma of the sigmoid may progress very slowly. Cases have been reported in which colostomy was performed for the relief of obstruction due to supposed carcinoma; the patients lived for a number of years, and died from carcinoma of the sigmoid, a fact which was taken to prove that the condition had been carcinoma from the beginning, and that the natural course of the disease had continued for eight or nine years. This inference is unwarranted. In the clinic we have operated in several cases of this type, and on resection of the growth have found carcinoma developing in a sigmoid in which the results of an ancient deforming type of diverticulitis were present. In tracing the early histories of the patients it could be seen that the diverticulitis had been present from the beginning of the illness, and that the malignant change had been a more recent development.

In reviewing a series of specimens of sigmoid which had been resected for supposed carcinoma at the clinic, Wilson found that three, resected years ago, before all specimens were subjected as a routine to microscopic examination, showed diverticulitis and not carcinoma. The possible association of carcinoma with diverticulitis leads to the conclusion that when a tumor, appearing to be diverticulitis, but without acute symptoms, is found in the sigmoid or colon, and especially if the tumefaction subsides only partially and then continues as a chronic mass causing more or less marked symptoms, carcinomatous change is to be suspected, but the relation between the two remains conjectural. Some idea of the relative frequency of the two conditions in the sigmoid may be obtained from our own figures. In the stated period we dealt with 696 cases of diverticulitis and 2,354 cases of carcinoma of the sigmoid.

The distinction between diverticulosis and carcinoma of the sigmoid can usually be demonstrated by radiologic methods. These methods will usually also show a carcinomatous change in a diverticulous area of the sigmoid, but if diverticulitis is present, this diagnostic agent cannot be used so freely during the more acute stages of the process.

SURGICAL TREATMENT.—The treatment of diverticulitis of the sigmoid

depends on many factors. In acute cases, especially if the patient is old, obese, and a poor risk for operative procedures, it should be tentative. In our series of 696 cases, operation was performed for this condition in 26.18 per cent. If the infection goes on to the formation of abscess, the pus should be evacuated, instead of waiting for its spontaneous discharge, as the latter course tends to lead to the formation of a fistula, with its attendant evils. If more radical treatment appears to be necessary to effect a cure, it can be postponed to a later and more favorable time. If acute obstruction results, colostomy should be performed as close to the obstructed point as is convenient, so that at a subsequent operation the stenosed portion of the sigmoid and the colostomy opening may be excised simultaneously through the same incision; or, as advised by Stiles and by Burgess, cecostomy may be performed for temporary relief and the radical operation performed later if it becomes necessary. In other cases, colostomy may be resorted to for temporary relief, and the opening in the colon closed later, if the infective process regresses spontaneously sufficiently to restore the lumen of the colon.

If the patient comes for relief of an internal fistula, especially one communicating with the bladder or with another part of the intestinal tract, a serious problem confronts the surgeon, the operative risk being proportionate to the number of internal fistulæ and to their situation. I know of no more trying operations than some of this character. In several instances I have dissected out multiple entero-intestinal fistulæ communicating with the bladder and have carefully sutured the bladder and each intestinal opening; after several days, leakage to the surface has followed the line of drainage with temporary discharge of urine and fæces. However, these wounds eventually have healed. A very excellent technical step in such cases was first suggested, I believe, by C. H. Mayo. This consists in completely separating the involved sigmoid from adherent intestines and bladder, and, after suturing the fistulous openings, or resecting the diseased segment of bowel, in bringing the omentum into the operative field. An opening is made in the omentum through which the sutured portion of the sigmoid is brought to the peritoneal surface of the abdominal incision, where it is attached by a few sutures. The omentum is thus thrown between the defects in the colon, bladder, and adherent intestines, and, if leakage occurs later, a safe exit is provided.

CONSIDERATIONS ON THE ORIGIN OF ACQUIRED DIVERTICULA OF THE SIGMOID

The romance of medicine lies in inductive philosophy, in which tomorrow is the great day. Yesterday furnishes the deductive philosophy, which acts as a compass to keep our directions true.

In mammals the testis is the primitive procreative organ, and because of its long heredity it is relatively free from disease; the ovary, secondary to the testis, is a more recent acquisition which has not yet achieved the same resistance. So, too, the sigmoid, a convenient storage organ but of more recent development, has not yet achieved the stability of the primitive small intestine. The right half of the large intestine is derived from the midgut, and in the embryo has the same type of epithelium as the small intestine

and carries on an absorptive function. The sigmoid is derived from the hind-gut, and has relatively little absorptive function. By reverse peristalsis derivatives of the food end-products are returned for further elaboration and absorption until the fecal stage is reached.

Certain recent investigations by Alvarez and his colleagues have shown the influence of food products on mass. Among the various types of food which form a mass, such common articles of diet as potatoes and milk form a relatively large mass, whereas red meats induce a large amount of bacterial action. Three-fourths of the peoples of the world eat rice for carbohydrate, and more or less fish for protein. Rice not only has a high-calorie content, but it also liquefies and forms only a very small mass; such articles of diet as fish also form a small mass. It would be interesting to know whether diverticulitis is as common in the rice- and fish-eating countries as it is in the potato- and red-meat-eating countries.

To one who has watched through the fluoroscope the spastic colon struggling with a barium content, it is not difficult to understand how and why pits form in the areas of weak musculature of the colon and along perforations made by its blood-vessels. Again, now that we are getting new light on the sympathetic nervous system, which acts as a brake on intestinal progress, we see a possible explanation of some of the phases of the development of diverticula. Learmonth and Markowitz have shown that after section of the inhibitory nerves to the colon of the dog, in certain cases, a barium meal may show appearances suggestive of early diverticulosis.

Speaking picturesquely, one notes various types of control over the vegetative functions, for example, the linking up of nonstriated muscle with the nodal system and with the internal secretions so largely instrumental in carrying on gastro-intestinal functions. These controls are shown in the occurrence of intestinal peristalsis once or twice in each minute and intestinal contractions eighteen or twenty times in each minute, the latter movements serving as a motor pump to propel venous blood in the portal system to the liver. All of these forms of stimulation are linked with the sympathetic nervous system, and through the sympathetic ganglions with the central nervous system. Our knowledge of this interrelationship we owe to the fundamental work of Gaskell and Langley.

The work of Hunter and Royle has stimulated fresh surgical interest in the sympathetic nervous system. In this field Adson and his associates have been able to relieve megacolon, which so closely resembles the dilated œsophagus in cardiospasm, by removal of the lumbar sympathetic ganglions and their communicating branches. The operation effects its purpose probably by leaving the sacral sympathetic outflow, which is motor to the distal part of the colon, in sole control of this part of the bowel. Adson and his co-workers have also brought about marvelous relief in Raynaud's disease, in certain types of contraction of the blood-vessels of the extremities leading to gangrene, and in certain types of arthritis, by removal of the appropriate sympathetic ganglions and their communicating branches.

END-RESULTS OF INGUINAL HERNIA OPERATIONS

By Charles L. Gibson, M.D.

AND

Robert K. Felter, M.D.

OF NEW YORK, N. Y.

This is a report of the operations for inguinal herniæ done on the First Surgical Division (Cornell) of the New York Hospital from May, 1915, to August, 1928. The operators have been doctors Gibson, Hitzrot, Lee, Farr, Weeden, Cornell and Wade. Only ward cases are considered.

Number of patients.................................... 1618

Number of herniæ..................................... 1878

(260 bilateral)

Male.. 1508

Female.. 110

Number of patients with recurrences...........48 (2.9 per cent.)

Number of recurrent herniæ................... 57 (3 per cent.)
(In addition to the original forty-eight recurrences, this number includes three cases which recurred a second time and six double recurrences.)

Number of cases recurrent at time of first admission, having had operation at another hospital......................... 51

(Of these two had had three previous operations; two had had two previous operations.)

Operative cure obtained in fifty of these cases.

Ages	No. of cases	Recurrences	Per cent. Recurred
1–10..........................	153	1	0.6 per cent
10–20..........................	193	0	0
20–30..........................	467	13	2.7 per cent
30–40..........................	374	15	4 per cent
40–50..........................	276	13	4.7 per cent
50–60..........................	128	4	3 per cent
60–70..........................	22	2	9 per cent
70–80..........................	5	0	0
Deaths....................................		8 (0.4 per cent)	

(In addition one case, age two, was transferred to contagious hospital where he died of scarlet fever.)

Follow-up Notes

Unknown... 146

Deaths (in hospital)................................ 8

Deaths (Scarlet Fever Hospital)..................... 1

3 months.. 567

4 months.. 267

5 months.. 122

6 months to 1 year................................ 341

1 to 2 years	99
2 to 3 years	12
3 to 4 years	12
4 to 5 years	12
5 to 6 years	10
6 to 7 years	9
7 to 8 years	3
8 to 9 years	3
9 to 10 years	4
10 to 11 years	1
13 years	1
Per cent of follow-up cases	90 9 per cent.

Types of Herniæ

One side

Indirect		1320
To include		
Sliding of sigmoid	28	
Sliding of cæcum	2	
Sliding of tube and ovary	2	
Sliding of appendix	2	
Sliding of broad ligament	1	
Direct. ..	..	111
To include		
Sliding of cæcum	1	
Sliding of sigmoid	4	
Sliding of bladder	2	
Direct and indirect		187
To include		
Sliding of sigmoid	5	
Diverticulum of bladder	1	

Bilateral

Indirect...	.	131
To include		
Sliding of cæcum	1	
Sliding of sigmoid	2	
Direct		40
To include		
Sliding of sigmoid	3	
Sliding of cæcum	1	
Direct and indirect .		34
Direct one side, indirect other side		12
To include		
Hernia of bladder	1	
Direct and indirect one side, indirect other side		29
To include		
Sliding hernia of sigmoid	1	
Direct and indirect one side, direct other side	.	14

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Complications: (Deaths not included—listed separately.)

Pulmonary:

Bronchitis. 32
Pneumonia. 34
Cough. 30
Influenza. 1
Infarct. 8
Embolism. 1
Empyema. 1
Pulmonary tuberculosis. 5
Laryngitis. 1

Skin:

Dermatitis from skin preparation. 6
Infective diseases. 21
Infection of wound. 70
(Some so slight as not to interfere with wound healing.)

Testicle and epididymis:

Epididymitis and orchitis. 21
Spermatocele. 1
Hydrocele. 74
Varicocele. 23

Hæmatoma. 59

Accidents at operation:.

Vas cut and repaired. 2
Bladder opened. 2
Cord cut (testicle excised on left). 1
Sigmoid superficially nicked. 1
Artery in meso torn—intra-abdominal hæmorrhage—operation
through right rectus incision same day. 1

Types of operation:

(Note.—General anæsthetic—of recent years chiefly ethylene
was used. In forty-one operations, local anæsthesia.)

We note that the great majority of operations are performed in the typical fashion of Bassini, 1221 being so listed. Three hundred and thirty-five operations are listed as Bassini with some form of modification, the most important being the utilization of the transplanted rectus muscle or of the rectus sheath, or the omission of transplanting the cord, two hundred and thirteen cases being included in this particular group.

The transplantation of the muscle or sheath is done chiefly in cases of direct hernia or obviously imperfect musculature. Some of the other modifications are only a question of detail, as, for instance, the item, "Bassini plus conversion," which simply means that the existing indirect and direct sacs were converted into one and removed as one.

The next largest number, dignified by an author's name, is the Wyllys Andrews, with one hundred and fifteen operations. Others are Stetten, with one hundred and eleven operations, the essential feature in this operation being the double overlap of the aponeurosis under the cord. We feel, how-

ever, that this and similar modifications are not of as great importance as the two capital underlying procedures; namely, the excision of the sac or sacs and the suitable reconstruction of the canal with the tissues in the plane posterior to the fascia. There were only two Gallie, thirty-seven Ferguson operations and fifty-seven Halsted. Our own feeling is that there is no essential difference between the Bassini and Halsted, for we do not believe that the suturing of the fascia of the external oblique under the cord adds materially to the strength of the canal providing the underlying procedures have been properly done.

Appendectomy.—The necessity or propriety of taking out the appendix through the right inguinal hernia opening is, of course, debatable, and some authorities condemn this procedure entirely. Other things being equal, we feel it is a justifiable procedure, providing it can be done with the maximum of care and gentleness. If the appendix and cæcum are not easily exposed we make no attempt unduly to drag them into the wound.

It is interesting to note that in several cases where we have abandoned the attempt to deliver the appendix, we have subsequently had to operate on these patients for an acute appendicitis, presumably the patients having a chronic appendix bound down to the surrounding tissues. Our figures show that in 1064 right-sided herniæ, 349 appendectomies were done (32 per cent.). Five of these were for acute appendicitis.

In our 1618 cases there were seventy infections, mostly trivial. Of these seventy infections, twenty-two were in cases where the appendix had been removed.

Résumé of Eight Deaths

1. W. P., age twenty-three, male. Right oblique inguinal hernia. Bassini operation. Infarct second post-operative day. Lung abscess. Thoracotomy. Died sixty-ninth post-operative day.

2. N. C., age fifty-two, male. Left oblique inguinal hernia plus sliding of sigmoid. Bassini operation plus rectus. Distension and pulmonary œdema—twenty-two hours post-operative died.

3. B.. G., age forty-two, male. Right oblique inguinal hernia. Bassini cord not transplated. Died of heart failure twenty-third post-operative day. (Chronic myocarditis and phlebitis of left leg.)

4. H. R., age fourteen, male. Right oblique inguinal hernia. Bassini. Died fourth post-operative day. Bronchopneumonia.

5. S. K., age fifty-one, male. Right oblique inguinal hernia. Woolsey modification of Andrews. Died eighth post-operative day, of pulmonary embolism.

6. L. S., age fifty-five, male. Bilateral direct and indirect inguinal hernia. Bassini. Died ninth post-operative day of pulmonary embolism.

7. S. B., age forty-five, male. Left oblique inguinal hernia plus sliding. Stetten operation. Died third post-operative day of pulmonary embolism (fat?).

8. J. S., age fifty-one, male. Left direct and indirect inguinal hernia. Conversion Halsted under local. Died fourth post-operative day. Embolism.

The majority of deaths are due to pulmonary embolism and the average age for fatal cases is rather high. Patients over fifty should not be operated on indiscriminately.

Résumé of Recurrent Herniæ

1. J. L., age twenty-seven. Right oblique inguinal hernia. Bassini with appendectomy. Infected. Direct recurrence two and one-half years after operation. Second operation—Stetten. O.K. nine months later.

2. M. W., age twenty-five. Bilateral oblique inguinal hernia (sliding). Bassini with Hotchkiss right side; Bassini plus rectus on left side; appendectomy. Direct recurrence on right side at four months. Second operation—Bassini plus rectus. O.K. thirteen months later.

3. J. R., age six. Right oblique inguinal hernia. Bassini. Right direct recurrence which occurred before seven months. Second operation—Bassini with rectus. O.K. one year after operation.

4. F. L., age thirty-five. Bilateral direct inguinal hernia. Bassini plus rectus plus Stetten—both sides. Bilateral recurrence fourteen months. Second operation—Bassini with utilization of internal oblique and transversalis. O.K. two years later.

5. P. C., age forty-three. Bilateral oblique inguinal hernia. Bassini operation—both sides. Considerable cough during convalescence. Recurrence left side, lower end of wound, at four months. Refused operation.

6. M. G., age twenty-eight. Bilateral direct inguinal hernia. Right side Bassini plus rectus sheath; left side Bassini plus rectus muscle; appendectomy. Recurrence right side at nine months. No operation.

7. A. L., age twenty-five. Bilateral saddle-bag hernia (direct and indirect). Bassini with conversion of sacs on both sides. Direct recurrence on left side at eight months. Hernia came through hole in the rectus sheath. Second operation—Bassini plus transplantation of rectus sheath. Left hernia O.K. two years eight months. At that time right side had recurred (direct). Refused operation.

8. P. S., age thirty-four. Bilateral indirect inguinal hernia. Bassini plus rectus both sides. Recurrence left side—five months. (Letter so states—patient never seen).

9. W. O., age forty-four. Bilateral inguinal hernia—right saddle-bag; left direct. Bassini plus rectus with division of epigastrics, both sides; appendectomy. Both sides infected. Recurrence three months both sides. Operation at another hospital.

10. P. McG., age twenty-five. Bilateral indirect inguinal hernia. Bassini both sides; appendectomy. Left side recurred one year—direct sac. Second operation—Bassini. O.K. one year post-operative.

11. D. G., age forty. Right direct inguinal hernia. Bassini plus rectus plus division of epigastrics. Infection of wound. Recurrence—direct—at five months. Poupart's ligament had separated. Bassini plus rectus plus Halstead. Hernia recurred second time at end of one and one-half years. No operation.

12. J. P., age thirty-seven. Right direct inguinal hernia. Bassini plus rectus. Recurrence one year—direct. Second operation—under local—Bassini with utilization of internal oblique and transversalis. O.K. fifteen months post-operative.

13. M. M., age thirty-seven. Right indirect inguinal hernia. Bassini operation. Recurrence three months. No operation.

14. N. A., age fifty-one. Left saddle-bag hernia with sliding hernia of sigmoid. Bassini plus rectus transplant. Recurred at one year—direct. Second operation—Wyllys Andrews with rectus transplant, cord being placed subcutaneous. O.K. five years four months later.

15. J. L., age twenty-nine. Bilateral indirect inguinal hernia. Bassini operation—both sides; appendectomy. Developed acute bronchitis post-operative. Left side recurrence—two months. No operation.

16. D. T., age forty-four. Bilateral direct inguinal hernia. Bassini plus rectus transplant. Both sides recurred—three months. No operation.

17. J. P., age 52. Right direct inguinal hernia. Bassini operation. Recurrence five months. No operation.

18. J. S., age twenty-seven. Right direct inguinal hernia. Bassini with rectus transplant. Hernia probably recurred immediately—indirect. Bassini with transplantation of the cord. O.K. ten months post-operative.

19. S. B., age forty-nine. Bilateral—right direct; left saddle-bag. Bassini operation both sides—muscle very poor. Recurrence left side six months. Operated on at another hospital.

20. S. G., age twenty-three. Bilateral—right indirect; left saddle-bag. Bassini operation both sides. Right side recurred one month—indirect. Stetten operation. Right side recurred second time six months. No operation.

21. H. T., age sixty-five. Left saddle-bag hernia. Wyllys Andrews. Recurrence with small impulse at end of five months. No operation.

22. J. K., age thirty-two. Bilateral indirect, inguinal hernia. Bassini operation—both sides. Left side recurred—six months. No operation.

23. J. McL., age forty-two. Right direct inguinal hernia. Bassini; appendectomy. Recurrence four months. No operation.

24. G. C., age twenty. Left indirect inguinal hernia. Bassini operation. Recurred immediately (letter from patient—never seen).

25. W. C., age thirty. Bilateral—right direct with sliding hernia of bladder; left indirect. Bassini both sides. Left recurred at seven months. No operation.

26. F. P., age thirty-five. Right indirect and direct inguinal hernia. Bassini operation; appendectomy. Hernia recurred at four years—indirect. Stetten operation. O.K. nine months later.

27. H. W., age fifty. Bilateral—right direct and indirect; left direct with hernia of bladder. Bassini repair—both sides. Both sides recurred—five months. No operation.

28. M. S., age forty-one. Bilateral—left indirect; right direct. Bassini on both sides. Right side recurrent three years—indirect. Second operation—Stetten. O.K. nine months later.

29. A. S., age forty-four. Bilateral hernia—left direct; right indirect. Right side recurred—one year. No operation.

30. M. S., age thirty-six. Right indirect inguinal hernia. Bassini; appendectomy. Recurrence two years. No operation.

31. A. F., age twenty-eight. Bilateral indirect inguinal hernia. Bassini operation both sides. Bilateral recurrence—direct—two years. Second operation on private side. No follow up.

32. J. J., age forty-two. Bassini operation. Muscle very poor. Developed persistent cough. Hernia recurred ten days after operation. No operation.

33. A. K., age forty-five. Left direct inguinal hernia. Bassini plus rectus muscle. Recurrence six months. Direct through external ring. No operation.

34. W. O., age twenty-one. Right indirect and direct inguinal hernia. Bassini with conversion of sacs; appendectomy. Recurrence before three months. No operation.

35. J. M., age thirty-four. Left direct inguinal hernia. Bassini operation. Recurrence before nine months. No operation.

36. P. R., age fifty-five. Bilateral hernia—right indirect; left indirect and direct. Bassini operation right side; Bassini with division of epigastrics left side. Left side recurred before seven months. No operation.

37. N. M., age thirty-one. Right recurrent direct and indirect inguinal hernia (former operation in Italy). Halstead plus rectus transplant; appendectomy. Hernia recurred second time—three months. Direct Wyllys Andrews with ligation of vessels. Developed pneumonia with severe cellulitis. Hernia O.K. three months. Then returned to Italy.

38. V. U., age thirty-two. Left indirect inguinal hernia. Bassini operation. Recurrence five months. No operation.

39. E. B., age twenty-two. Left indirect inguinal hernia. Bassini operation. Recurrence before four months. No operation.

40. R. B., age forty-eight. Bilateral direct and indirect inguinal hernia. Bassini repair both sides; appendectomy. Recurrence left side before three months. No operation.

41. L. S., age thirty-five. Bilateral indirect inguinal hernia. Bassini operation—both sides. Recurrence five months—right side. No operation.

42. N. N., age forty. Right indirect inguinal hernia. Bassini operation. Local anæsthesia. Developed acute bronchitis. Recurrence before seven months. No operation.

43. J. K., age thirty-one. Right indirect inguinal hernia. Bassini operation. Recurrence nine months. No operation.

44. M. K., age thirty-seven. Left indirect inguinal hernia. Bassini operation. Recurrence before eleven months. No operation.

45. F. Z., age sixty-three. Right direct and indirect inguinal hernia. Wyllys Andrews plus rectus sheath translant. Hernia recurred fourteen months. Direct. Second operation—Gallie. O.K. ninth months—post-operative.

46. S. C., age forty-nine. Bilateral—left indirect; right direct and indirect. Left side Wyllys Andrews; right side Stetten plus rectus muscle and sheath. Right side recurred before four months. Indirect. Second operation—Stetten. Recurrence seven months later. No operation.

47. A. M., age twenty-eight. Right indirect inguinal hernia (congenital type). Bassini operation. Recurrence before three months. No operation.

48. F. B., age thirty-nine. Bilateral direct inguinal hernia. Halsted operation—both sides. Developed persistent cough after operation. Recurrence right side before sixteen months. No operation.

Summary of Recurrences

Total no. of cases.. 48
Bilateral (all done at one sitting)...................... .. 23

Types of Herniæ Which Recurred

One side

Indirect... 12

13 Direct
{
Direct.. 7
Direct recurrent (first operation at another hospital)... 1
Indirect and direct................... 4
Indirect and direct (plus sliding of sigmoid).......... 1
}

Bilateral

Indirect... 7
Indirect plus sliding.............................. 1

15 Direct
{
Direct.. 4
Direct and indirect............................... 2
Direct and indirect one side, indirect other.......... 3
Direct and indirect one side, direct other............ 2
Right side direct with sliding hernia of bladder, left indirect.. 1
Right direct and indirect, left direct with hernia of bladder... 1
Indirect one side, direct other..................... 2
}

Time of Recurrence:

Immediately	3
1 month	1
2 months	1
3 months	7
4 months	5
5 months	7
6 months	3
7 months	4
8 months	1
9 months	3

35 cases nine months or under (72.9 per cent.)

Average time of nine-months period, 4.6 months

11 months	1
14 months	2
16 months	1
1 year	4
2 years	2
2½ years	1
3 years	1
4 years	1

13 cases over 9 months (27.1 per cent.)

Of the 427 direct herniæ, 28 recurred (6.5 per cent.). Of the 1451 indirect herniæ, 20 recurred (1.3 per cent.). Of the single herniæ, 1618 cases. 25 recurred (1.5 per cent.). Of the bilateral herniæ, 260 cases, 23 recurred (8.9 per cent.). Of the 48 recurrences 17 were re-operated on.

There is a difference of opinion as to whether bilateral operations should be done in one or two sittings. On the whole we believe that doing a bilateral operation at one sitting increases the possibility of recurrence, as twenty-three of our total forty-eight recurrencese were bilateral herniæ done at one sitting.

The critical reader will at once remark, and very properly, that our figures have relatively little value in that the time of observation in many cases is not sufficiently prolonged. Our normal procedure is to notify the patient on his discharge that he will be asked to return in three months, and to return at any time if he has trouble. This admonition, we believe, is of value and has resulted, as noted in the above figures, in the return of patients some times over many years.

Knowing that we many expect more trouble with the direct hernia, patients are requested to return at the end of nine months. We have chosen nine months because if we leave it for a year with the shifting population we are likely to lose a considerable number of cases. We believe, however, that even with this acknowledged deficiency we have a fairly reliable picture of the status of valid results as 72.9 per cent. of our recurrences recurred within the nine-months period, the average time for that period being 4.6 months.

We call particular attention to the marked difference in the results between direct and indirect hernia, and also the preponderance of recurrence in bilateral cases.

Direct herniæ.—For many years we have been impressed with the necessity

for more thorough operations on direct herniæ. It is particularly important to recognize that there is a direct hernial sac and to exhaust every possibility to demonstrate and exsect it. Even relatively large direct herniæ may not show an obvious sac at the time of operation until it is clearly demonstrated by painstaking dissection. One of the simplest methods of demonstrating a direct sac is to isolate and expose the indirect sac and pass the finger downward into the canal where it will readily cause the direct hernia to protrude. The failure to look for and establish the presence of a direct sac in an obvious indirect sac, is perhaps the most frequent cause of failure to cure a direct hernia, for we believe that the cure of a hernia lies in the recognition and exsection of *all sacs*.

The dissection of the direct sac is sometimes tedious; but it must be thorough and it is in these operations for direct hernia that there is a possibility of trauma to the bladder. In addition to the proper handling of the sac it is important to utilize proper anatomical structures for the perfect closure of the canal, for it is in these cases where the so-called conjoined tendon is valueless as material.

Our preference is to make an incision at the anterior outer edge of the sheath of the rectus, passing interrupted chromic catgut sutures through the presenting edge of the rectus muscle and through the deepest layer of Poupart's and Gimbernat's ligament. As additional security, the mesial cut edge of the sheath of the rectus is similarly sutured superior to the first layer. It is important to use the mesial edge, for the outer edge is valueless, as it frays out.

GENERAL CONSIDERATIONS.—Operations for inguinal hernia are generally satisfactory, both as regards cure and danger to life and relative freedom from complications. There still exists room for improvement. The mortality would be negligible but for the incidence of pulmonary embolism, a still unsolved problem.*

Who should be operated on?—Practically all young and healthy individuals. Very young children can usually wait as they are not very apt to develop accidents. Individuals past fifty, the class most prone to a higher mortality and percentage of failures to cure, should ordinarily not be operated on except for definite indications, unusual discomforts, disability and strangulation.

Source of failures.—The greatest single factor is the sac. If easily identified and radically dealt with, as in indirect hernia, the results are good. Direct hernia is a different and special problem. Sacs are overlooked and improperly handled and, in addition, special forms of closure, such as transplantation of the rectus, are necessary, also longer stay in bed.

The highest incidence of recurrence, bilateral hernia operated on at one sitting, is disturbing and we must seek for improved results. The operation

* Sufferers from hernia sometimes die from embolism without undergoing operation.

may be prolonged and possibly fatiguing and its details not so accurately executed.

It is our practice usually to do difficult and extensive double herniæ, particularly the direct, in two stages.

If an insufficient operation has been done, the failure promptly becomes evident, 72.9 per cent. of recurrences being within nine months.

Our records show only two instances of the Gallie operation. We doubt if this operation is an improvement over current methods. We are influenced by our gratifying results in extensive abdominal herniæ, where we only utilize the various structures of the abdominal wall.[1]

BIBLIOGRAPHY

[1] Gibson, Charles L.: Operation for Cure of Large Ventral Hernia. ANNALS OF SURGERY, August, 1920.

SLIDING HERNIAS OF THE ASCENDING COLON AND CÆCUM, THE DESCENDING COLON AND SIGMOID, AND OF THE BLADDER

By ARTHUR DEAN BEVAN, M.D.

OF CHICAGO, ILL.

A FEW months ago while I was doing an operation for radical cure of a left inguinal hernia, on one of my colleagues, I found that I had to deal with a sliding hernia of the descending colon and sigmoid. I did the operation under local anæsthesia. I took the occasion to quiz some of my assistants and
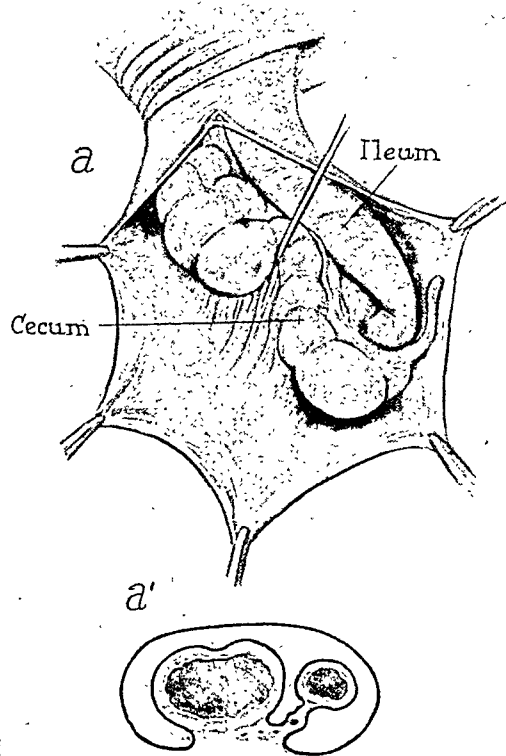
FIG. 1.—Cross sections of sliding hernia of the cæcum and ascending colon.
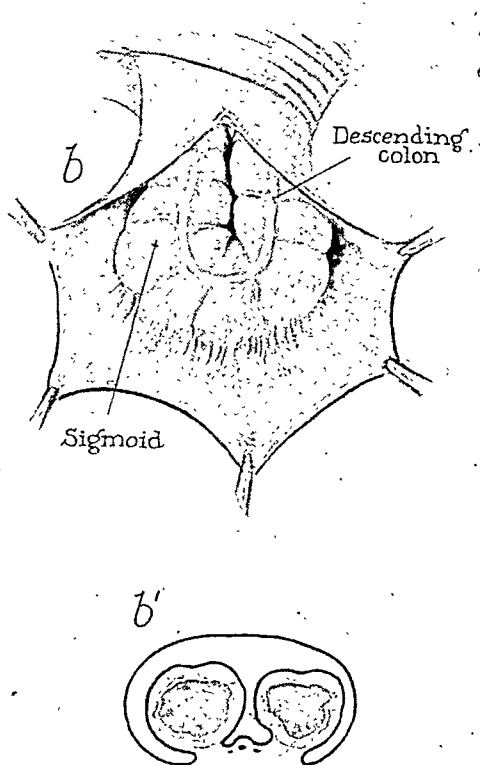
FIG. 2.—Cross section of sliding hernia of the descending colon and sigmoid.

younger surgical colleagues and found that their conception of sliding hernias and the proper methods of operating upon them was rather vague.

This experience made me feel that it might be well worth while to again review this subject and present a method of operation which I have employed in a number of cases and found to be exceedingly satisfactory. I have found in my own work three different forms of sliding hernia: first, the sliding hernia of the cæcum and ascending colon; second, the sliding hernia of

the sigmoid and descending colon; and third, the sliding hernia of the bladder.

An English surgeon, Albert J. Walton, of London, has an excellent article on Extrasaccular or Sliding Hernia in the ANNALS OF SURGERY, Vol. lvii, p. 86, 1913. He very well defines the condition as follows:

"Extrasaccular or sliding hernia is one in which some portion of the wall is formed by a viscus which in its normal position is only in part covered by peritoneum. It is thus seen that this viscus in the inguinal or femoral region may be either bladder, cæcum and ascending colon or iliac, *i.e.*, descending colon and sigmoid." (See Figs. 1 and 2.)

I can remember very well the first case that I operated on of sliding hernia of the cæcum and ascending colon. It was more than thirty years ago. I operated on a good-sized inguinal hernia of the right side. When I opened the large sac I found that the cæcum and ascending colon were apparently adherent to the posterior portion of the sac. I proceeded to
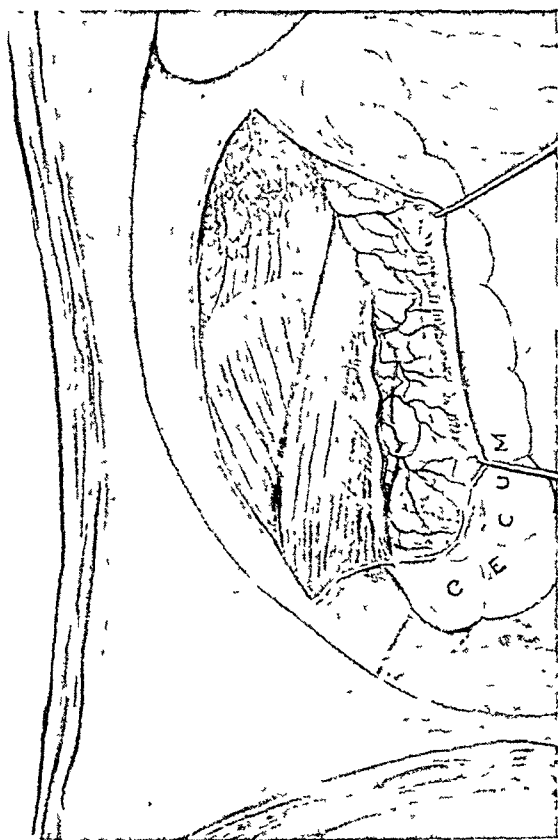
FIG. 3.—Showing blood supply and the method of mobilizing the cæcum and ascending colon within the abdominal cavity in resecting the colon for carcinoma and other lesions.
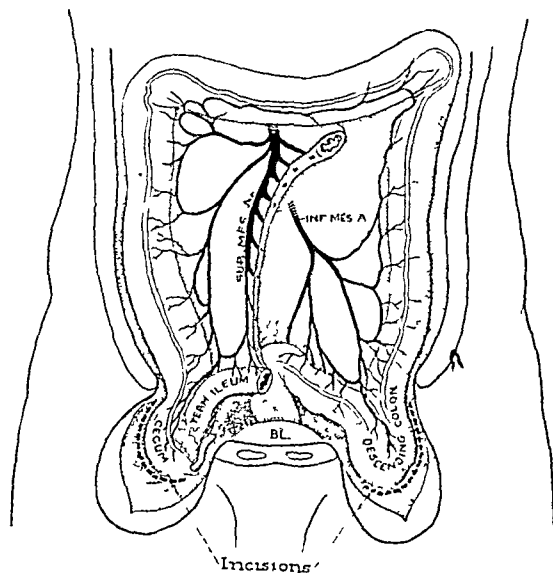
FIG. 4.—Showing blood supply of sliding hernias of cæcum and ascending colon and of the descending colon and sigmoid, and incision necessary to safely mobilize the bowel in the hernia sac by dividing the outer avascular layer of the mesocolon.

separate what I regarded as adhesions and I then found that I was dividing the mesentery of the cæcum. Fortunately, I did not damage the vessels of the gut sufficiently to cut off the blood supply. I did, however, divide the mesentery and peritoneum sufficiently to enable me to return the bowel into the peritoneal cavity and then closed the hernial sac with a catgut suture and repaired the hernia by the Bassini method, fortunately obtaining a cure. I then reviewed the literature and obtained a fair conception of the condition. Gradually in my clinic I accumulated a considerable experience with the

various forms of sliding hernia so that I was able to master the problem when it occurred unexpectedly, as it almost always does, for I cannot remember making a diagnosis of this condition before the operation.

It is very necessary to have a thorough understanding of the anatomy involved in these sliding hernias in order to operate upon them safely and successfully. It is well known to abdominal surgeons that the entire colon except the rectum can be mobilized by dividing the outer layer of the mesocolon; the outer layer is avascular; it contains no blood-vessels. We t a k e advantage of t h i s f a c t when we resect the cæcum and ascending colon, or the descending colon and sigmoid, or, in fact, any part of the colon except the rectum. The blood-vessels of the colon come from the inner side. Keep this fact in mind in handling sliding hernias of the cæcum and ascending colon on the right side and hernias of the descending colon and sigmoid on the left. See Figs. 3 and 4 of the blood supply.

The technic which I desire to present has been a matter of gradual development in my hernia work and covers probably a period of twenty years. This technic was first employed in operations on direct inguinal hernias. I found in operating on these cases of direct hernia that, as a rule,
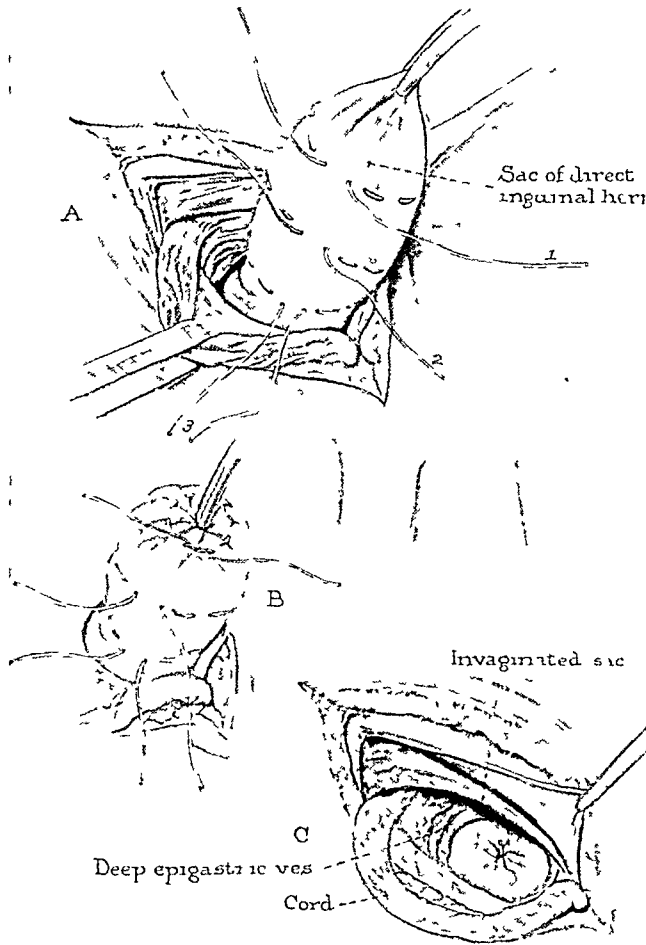
Fig 5 —Invagination method of treating the sac in direct hernia and method to be employed in sliding hernia of the bladder, and moderate size sliding hernia of the colon

the sac could not be isolated in the same clean-cut way that it can be in the indirect inguinal hernia. The mouth of the sac is often wide, sometimes very wide, and the closure by transfixion and ligation is not nearly as satisfactory as in the indirect hernia. I began to look for a better method of dealing with these sacs and I found it in the method of invaginating the sac into the peritoneal cavity with two or three or even four purse-string sutures of rather

durable catgut. This method secures a fine closure of the peritoneal sac of a hernia. The peritoneum lends itself well to such a method of obliterating the sac permanently by the plastic reparative peritonitis which this invagination by purse-string sutures produces. (See Fig. 5.)

In doing a large number of direct hernias by this method, I employed it in a number of cases of direct hernia which involved the bladder wall,

Fig. 6—Technic of operation for large sliding hernia of the cæcum and ascending colon: First, opening the sac freely along the anterior surface; Second, mobilizing the bowel by dividing the outer layer of the mesocolon, gently replacing the bowel into the peritoneal cavity.

the sliding hernia of the bladder, and I found that it was the simplest and best method that I had ever used for sliding hernia of the bladder.

Later I began to employ this method in sliding hernias of the cæcum and ascending colon and of the descending colon and the sigmoid and found that it was the simplest and best method in these sliding hernias of the large intestine, except sliding hernias of large size. In these the invagination method with purse-string sutures of catgut can be used as a part of the technic, but in the large sliding hernias with a large segment of colon in the sac it may be necessary to employ a special technic to mobilize

the colon so that it can be returned into the peritoneal cavity without any injury to its blood supply (see Figs. 6 and 7); in very large sacs it may be better to remove a large part of the sac and then invaginate the rest by the purse-string suture method. The surgeon who is operating on a good many
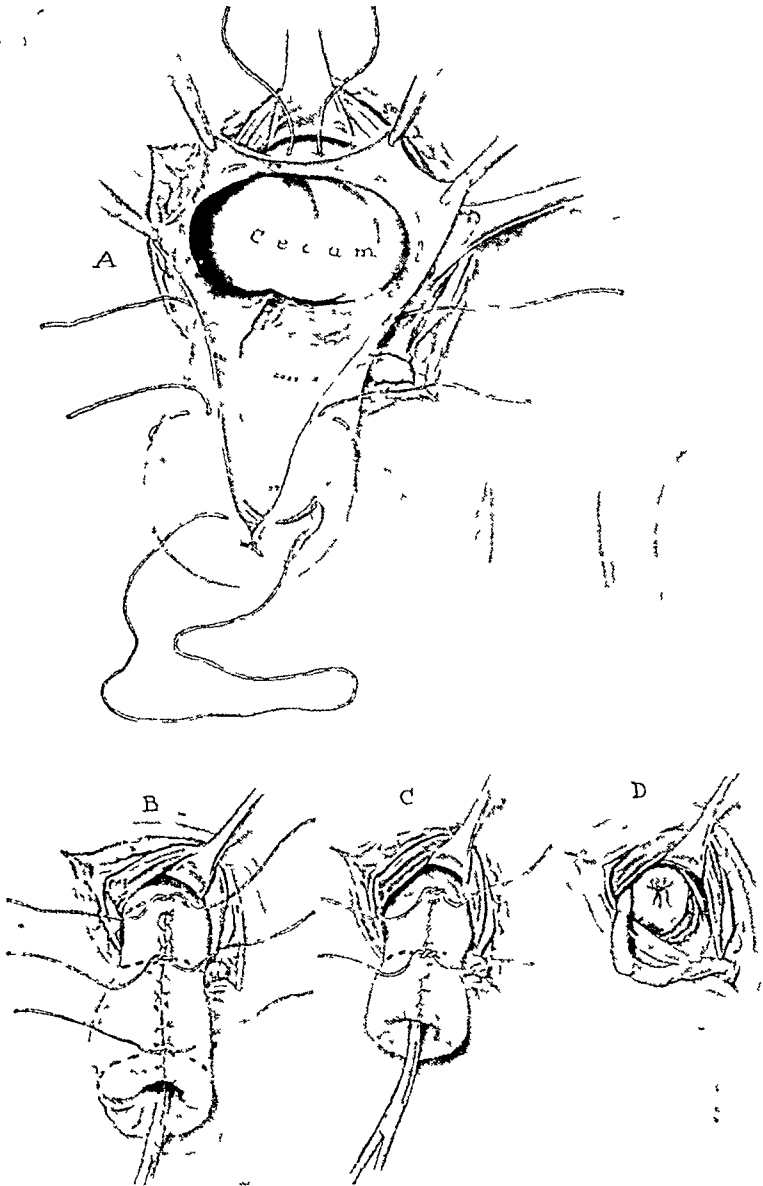
FIG 7 —Third, introducing three purse string sutures while the sac is still open, Fourth, sew up the incision in the anterior surface of the sac and invaginate the sac with three purse string sutures into the peritoneal cavity In very large sliding hernias with very large sacs the excess portion of the sac should be removed and the balance invaginated as described

hernias will run up against many sliding hernias of the colon and bladder, and it will be well for him to be prepared to meet these difficult problems. Sliding hernias occur in about 1 per cent. of hernia operations.

This technic will appear clearer by a careful study of the series of plates shown.

It has now been amply proven both by clinical work and by work in the experimental surgical laboratory on dogs that the strength of the closure in inguinal hernia depends upon the proper closure of the external oblique aponeurosis. This is the strong structure which withstands intra-abdominal pressure. The union of fascia to fascia is much stronger than that of muscle to fascia. (See Fig. 8.)
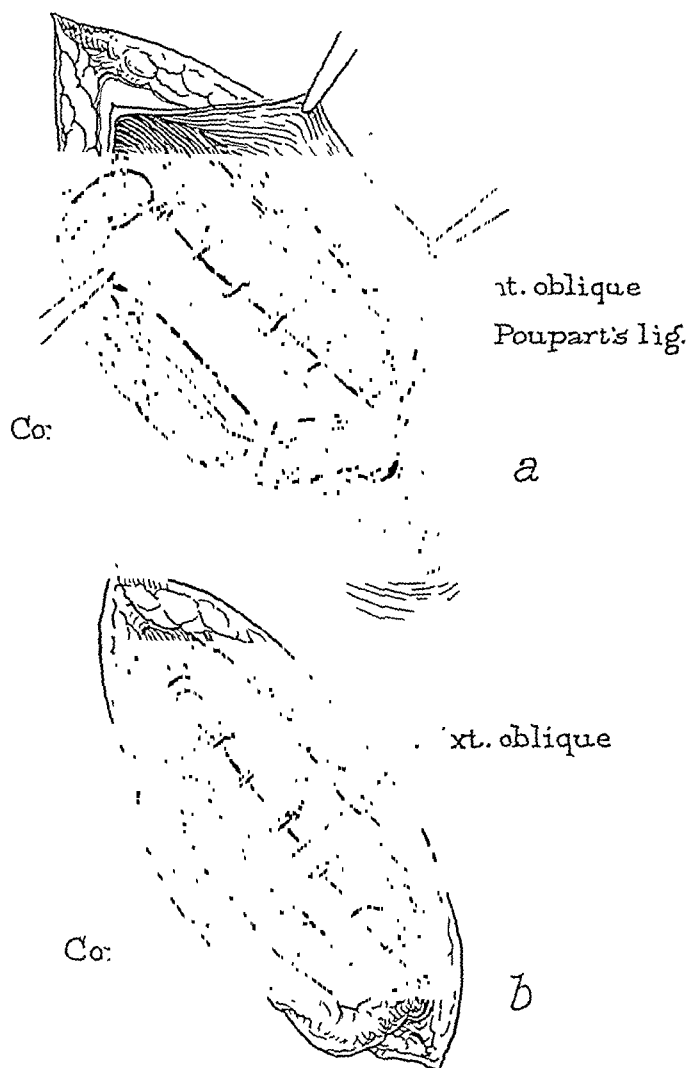
Fig. 8.—Fifth, close the canal by the only sound method of doing an inguinal hernia which is as follows: Elevate the cord as in the Bassini operation; close the canal with first a continuous suture, which brings the conjoined tendon to the shelf of Poupart's ligament, and a second continuous suture which brings the edge of Poupart's and the inner edge of the external oblique accurately together with the cord still elevated. The cord is now covered with the superficial fat by running sutures of fine catgut which sews together the deep layer of the superficial fascia.

I have felt that the importance of the anatomic and surgical principles involved in this rather rare and difficult problem of sliding hernia and the results which have been obtained by the operation which I have developed warrant my presenting this subject to you.

The method of Dr. Moschcowitz necessitates a laparotomy. He thought it could be eliminated. Invagination with two or three purse string sutures works admirably, because as one invaginates the first suture, one apparently

simply pushes back a part of the sac, let us say a third. As one does the second, one has two-thirds of it back. As one does the third suture, introduced right under one's eye, it brings the peritoneum snugly up well inside the internal ring. That is the secret with it, that is the ease with which the three purse string sutures enable one gradually to push back the colon and retain it back in position. It is very desirable not to complicate the operation with a laparotomy. He was quite converted to the position that the one way of doing an inguinal hernia to give the patient the best prospect of cure and the least prospect of recurrence is the suture of the external oblique under the cord. The work of Seelig in the laboratory shows that the sewing of the conjoined tendon of muscle to fascia gives very little strength, that what one requires is a drumhead, a firm drumhead that does not yield, and this is obtained by a closure of the external oblique to the edge of Poupart's that extends up from the angle at the symphysis to the internal ring. Nothing comes out at the internal ring except the cord. What one needs most of all is this absolute closure from the angle to the internal ring. That can certainly be better brought about by uniting the external oblique to the edge of Poupart's which we no longer imbricate as a rule; it is important not to imbricate it if in doing so one puts the structure on tension. One should have plenty of the external oblique in order to imbricate.

The clinical evidence is this: surgeons have cured repeatedly, especially in direct herniæ, recurrences by this method where the ordinary methods have failed. That is not in one case but in a great many cases cure has been secured permanently in direct herniæ that have recurred after operation.

UROSELECTAN INTRAVENOUS UROGRAPHY

By Edwin Beer, M.D.

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THE retrograde introduction of radiopaque materials, particularly radiopaque solutions into the urinary organs, has led to a most remarkable improvement in diagnostic accuracy. The development in the interpretation of the pictures obtained has been unusually rapid and complete. In 1923, Osborne, Sutherland, Scholl and Rowntree made more or less successful attempts to avoid the usual retrograde method by administering iodides intravenously and by mouth. Added stimulus was given to these researches by Graham's successful work on the gall-bladder visualization. Rosenstein, von Lichtenberg, Volkmann, Lenardouzzi, Pecco, Hryntschak and Roseno have contributed to these investigations, but it remained for M. Swick[1] to finally solve this difficult and most important problem.

After working with selectan neutral, synthesized by Professor Binz and Doctor Raeth, on the Medical Service of Professor Lichtwitz in Altona, Germany, and failing to obtain satisfactory results with any regularity, a new preparation was tried by him without the methyl group (which may have been responsible for mild toxic symptoms, including double vision) and this new preparation is the uroselectan that is being used at present. Uroselectan is non-toxic, very soluble in water and it is excreted under normal conditions almost completely within eight hours, producing no irritation in the urinary tract. It is administered slowly intravenously in doses of forty to sixty grams[2] (less in children) and exposures are made beginning fifteen minutes after the injection. As the intensity of the shadows obtained varies with the function of the kidneys, uroselectan is proving to be a test of renal function. In its passage through the kidney, it intensifies the kidney outline and as it is excreted into the pelvis it fills the calices and pelvis, as well as the ureter and the bladder—all of which are readily visualized on the röntgen film.

Without going into extensive details as to the nature of the drug, the exact method of its administration, the estimation of the amount excreted which also gives us a new functional test, the use of air compression to produce more intense pictures and the administration of divided or double doses, some of which points Swick has partly described in brief in his last publication[3] and will shortly publish in greater detail, I would like to call attention to the possibilities of this method.

We have been particularly fortunate in our studies with uroselectan to have Doctor Swick attached to my service since his return from Europe, and he has, with the coöperation of the Mount Sinai Hospital X-ray Department, as well as with the office equipment, demonstrated to my satisfaction the great value of his method. Whether this preparation will be improved upon,
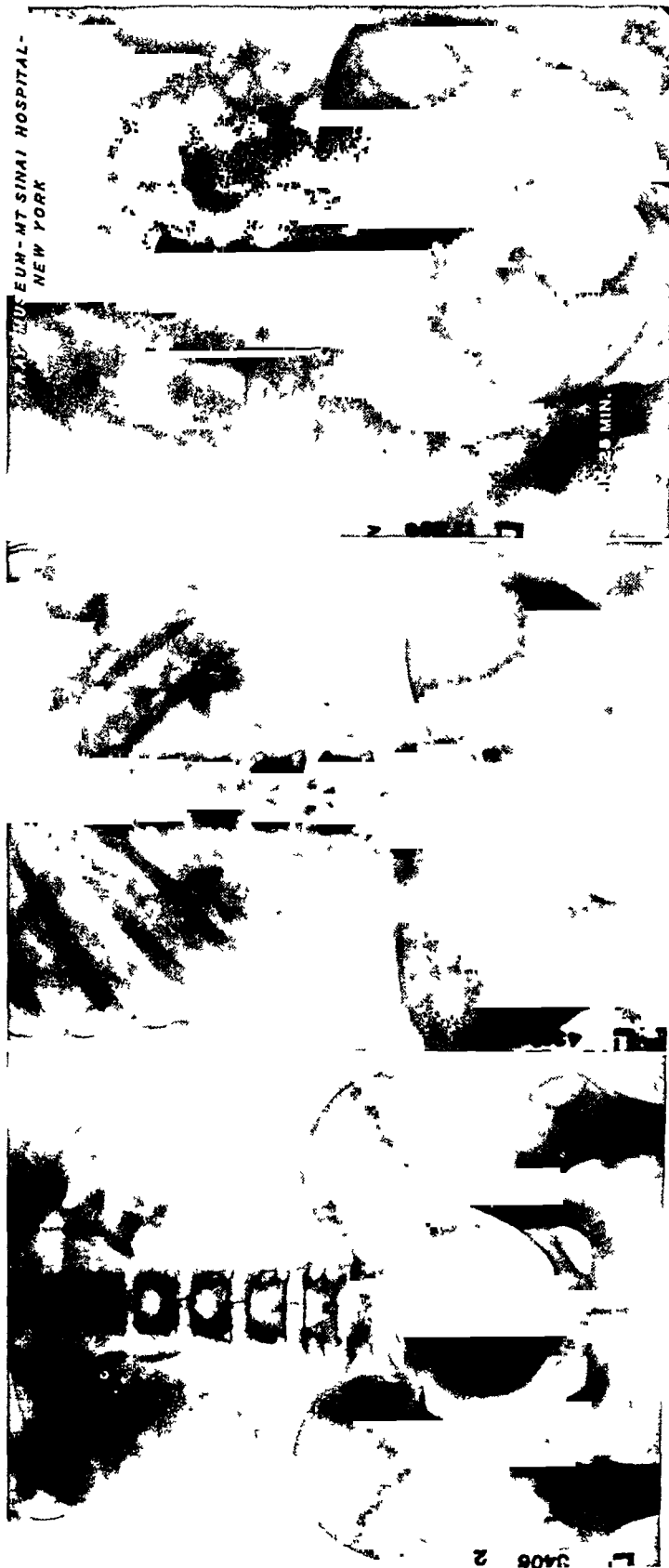
Fig. 1 —M. H., child of thirteen years, who may have had pyelitis Intravenous urography outlines kidneys and almost normal pelvis Ureters are completely filled, almost to bladder and bladder shadow shows almost symmetrical organ

Fig. 2 —J. M., female Suspected of having uric acid stone Repeated examination was negative Intravenous examination shows normal contour of kidneys, which are very distinctly intensified, normal pelvis with slightest dilatation on the right side Ureters distinctly filled, and the bladder clearly outlined, of normal contour

Fig. 3 —C., male Resection of bladder for cancer, transplantation of left ureter Intravenous urography shows both kidneys are functioning, slight hydronephrosis, hydroureter on the side of the transplanted ureter and there is some deformity in the bladder outline where the bladder was resected

Fig. 4.—P., child. Extrophy of bladder. Bilateral transplantation of ureters into sigmoid. Intravenous urography shows slightly dilated ureters and pelvis, involving calices. Ureters can be traced well down in some of the pictures, and the rectum is filled with some of the opaque material.

Fig. 5.—S., adult male. Prostatic obstruction. Intravenous urography shows marked dilatation, especially of left pelvis, upper ureter and calices. Ureters on both sides clearly outlined and in the lumbar region a very marked ureteral kink. Large bladder is clearly filled. In this patient, cystogram from below showed reflux up both ureters and practically the same picture as the intravenous urogram.

Fig. 6.—A., child. Left kidney enlargment. Intravenous urogram shows large hydronephrotic left kidney, large pelvis and dilated calices. On the right side at this exposure the normal pelvis is almost empty.

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whether per oral urography with other drugs will be a further development in this field, remains to be seen.

It has been suggested that this new method will do away with retrograde urography and perhaps allow the profession to dispense with the cystoscopic examination. This, I believe, is a hasty conclusion and not warranted by the facts as I see them. I am convinced that the more or less routine use of uroselectan urography is surely going to discover pathology in the urinary tract which now is unnoticed except by the patient. Separation of kidney specimens, visualization of the interior of the bladder, pyelo-ureterography to confirm the findings made with uroselectan will be more frequently necessary in the future than in the past, when medical practitioners, general surgeons, gynecologists and urologists insist on a preliminary uroselectan urography as a more or less routine procedure.

Intravenous urography will be of great use in children in whom cystoscopic procedures may require complete anæsthesia, as well as in patients who are intolerant, either because of local pathology or because of their mental make-up. In badly diseased bladders, where one or both ureters cannot be located or entered far enough to obtain a retrograde pyelogram, it will and does prove of supreme assistance. In cases in which the ureters have been transplanted into the bladder, as after a resection, or into the sigmoid, uroselectan urography alone can give us an adequate picture of the transplanted ureter, pelvis and kidney. At the same time, it gives us a fair idea of the transplant's function.

In a study of eighty-four urological cases published by von Lichtenberg and Swick,[4] sixty-one cases, or 75 per cent., gave satisfactory diagnostic data. Our experience confirms their experience, that excellent shadows are obtained in normal patients, as well as in incomplete obstructive conditions, such as hydronephrosis, ureter and kidney stones, provided renal function is adequate. If no shadow is obtained, either there is no kidney or the organ is almost functionless. Function may also be inadequate in bilateral obstruction, as in prostates, in renal tumors and pyonephroses.

The interpretation of the pictures obtained with uroselectan requires some experience as their clarity varies with the kidney function. In retrograde urography, the urinary tract is filled from below and at times distorted pictures are produced by distention or over-distention. Naturally, this does not happen with intravenous urography, and in studying the pictures obtained, one has to be reëducated to some extent. The sharp pictures that we have been accustomed to are less frequently obtained with the intravenous method, even though as a rule very adequate delineation of the upper tract can be seen, provided always that the excretory activity of the kidneys is not greatly reduced.

From these brief remarks, it must be evident that with intravenous urography many unsuspected lesions in the urinary tract will be readily discovered and all sorts of new viewpoints will be developed, which will clarify and elucidate hitherto unsuspected phases of urinary pathology.

The reproductions shown were made from films taken of patients injected by the Swick method with intravenous uroselectan by Doctor Swick.

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DISCUSSION: DR. WILLIAM E. LOWER, of Cleveland, had tried out this method of diagnosis to a very limited extent and was able to confirm what Dr. Beer had so graphically shown. There is one question that must be considered, and that is how accurate this is going to be as a functional test. Until we can check it up against the other functional tests we must reserve our opinion as to its usefulness in that way, but as a method for outlining the kidneys and as a method for aiding in diagnosis in cases in which one is unable to do a ureteral catheterization, it is a wonderful advance. He thought it one of the greatest aids that have occurred in Urology in a long time.

COCCUS INFECTIONS OF THE KIDNEY

THEIR FREQUENCY AND THEIR RELATION TO THE UPPER RESPIRATORY TRACT

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As LONG ago as 1889, Albaran clearly recognized this type of renal infection, pointed out its hæmatogenous origin, described its frequent involvement of the glomerular structures, its tendency to form multiple abscesses, perinephritic abscesses, etc. He believed that trauma to the kidney was an important factor. It is next interesting to recall that George Brewer, a member of this Association, in communications in 1911, 1913, and 1915, clearly drew the picture of the more severe infections, and drew attention sharply to their importance. There is, of course, an enormous literature· which it would be futile to attempt to summarize. We call attention, however, particularly to the work of Helmholz and Milliken, Bumpus and Meissner, and Rosenow, whose contributions have been made, as I think, basic in this study.

In this paper we wish particularly to call attention to the frequency of this type of infection, to certain points in its etiology, to certain, as we think, helpful methods of diagnosis, and to suggest a possible sequential relationship between these acute infections with pus-producing cocci and the much more chronic infections believed to be caused by the colon bacillus group.

Frequency.—Most writers on this subject have been chiefly concerned with the more severe types of infection, though several have drawn attention to the occurrence of milder forms in which, however, they generally found the diagnosis difficult. Using a method of diagnosis later to be described, we have come to the conclusion that these milder degrees of infection are not only uncommon but are probably very common. During the last two years at the University Hospital, we have encountered over forty cases, of which we have satisfactory records of twenty-seven. We shrewdly suspect that these infections frequently occur as complications of infections of the upper · respiratory tract, of septic wounds and of cutaneous infections of various kinds and are commonly charged off to the infections when, in fact, the increased fever, *etc.*, is of renal origin. Cases III, IV, VI, X, XII, XIII, XIV, XV, XVI, XVII, might easily have been charged off to the primary infection had attention not been focused upon the possibility of this renal complication.

Etiology.—Although it has long been recognized that bacteria from a local inflammation may frequently enter the blood, and though, of course, such bacteria, if they survive, must undoubtedly reach the kidneys, the full significance of this has not perhaps been sufficiently clear. On this point a recent article by Scott[1] is important. Studying a large group of urological cases on the service of Dr. H. H. Young during a period of two years, he obtained

positive evidence of blood-stream infections in eighty-two different cases, 62 per cent. of these cases following operation. Of the positive blood cultures, 77 per cent. were bacillary and 23 per cent. were coccal infections of the blood-stream. This communication seems to me important as showing the relative frequency of blood-stream infections, the chief evidence of which was transitory febrile reactions.

Attention has frequently been called to the apparent association of so-called pyelitis in children with infections of the upper respiratory tract. The difficulty in regarding them as directly related has been that the organisms infecting the upper respiratory tract were practically always various forms of cocci while the organisms found in the urine were, in the great majority of cases, bacilli of the colon bacillus group. In our series of cases, there occurred seven in which the relationship between the respiratory infection and the infection of the kidney seemed quite clear. In at least one of this group, XV, which ran a rather longer course, bacilli appeared in the urine some time later in convalescence. In several of the other cases, notably III, VIII, XVIII, and XIX, the early pure coccus infection was succeeded by a mixture with colon bacilli. This observation appears to us to throw some light upon the suggestion previously made by many other observers, that the very large percentages of kidney infections showing colon bacilli, at least in the later stages, represents an unduly large proportion of the cases in which this organism is the original malefactor. It tends to accentuate the opinion previously expressed by many observers that the colon bacillus group may be chiefly a relatively late interloper which overgrows the original infection and finally takes possession of the field. It suggests that the original infection may be much more commonly with the coccus than we have supposed and that we should look to this as the original source of insult to the kidney leading to the later condition which we rather roughly classify as pyelitis.

To two cases in this group we wish to call particular attention. We have for years been familiar with the rather vague clinical entity described as defloration cystitis. Personally, we have long believed that the element of cystitis was but a symptom of a renal infection due to organisms entering the circulation through various hymenal tears. Cases I and II tend to support the view that these infections are blood-stream infections, affecting the kidney primarily and that at least in some cases the coccus is the primary infecting organism.

Diagnosis.—It has long been recognized that in this group of renal infections, the urine showed but the slightest evidences of abnormality and the diagnosis had therefore to be made largely upon physical examination showing tenderness over the kidney, importantly in the costo-muscular angle, enlargement of the kidney and evidence of perinephritis. Many years ago in a paper with Crabtree, we called attention to the fact that a scrupulous examination of the urine in these patients would commonly show cocci in numbers so great as to bar the possibility of contamination. This method has now become our main reliance in diagnosis and we depend chiefly upon the results of

smears taken from the often apparently normal urine which has been highly centrifugalized, using only very fresh specimens and only specimens obtained by catheter in the case of female patients. Stained specimens taken from the very moderate sediment obtained by means of the prolonged use of the high-speed centrifuge, will almost always show cocci in large numbers, sufficient, as we believe, to justify the diagnosis.

As was pointed out by various observers in the past, these organisms are most commonly found in the early days of the condition. To this observation, we add the fact that they may not appear for a few days after the onset, at which time they may be found in large numbers. A further observation originally made, I think, by Crabtree, is that in a fair proportion of the cases, though the stain was satisfactorily taken, the organisms will not always grow satisfactorily upon ordinary culture medium. This may very likely be due to our unskillful bacteriological technique. However, the method of study of centrifuged specimens by stain seems to us clinically satisfactory and can, we believe, be depended upon for accurate diagnosis with greater certainty than by culture. The finding of cocci in large numbers in the urine, coupled with the clinical picture of moderate renal infection, is, we think, sufficient to establish the diagnosis.

Course of the disease.—A study of the appended cases will clearly show that the condition in many cases runs a short course, ending in complete recovery, except insofar as there are undoubted lesions of the glomeruli which, however, are probably not of importance to the renal function. We shrewdly suspect that if these cases are carefully watched for, we should come to the conclusion that these coccus infections of the kidney are common and generally of a mild type. A few of our cases, on the other hand, must be classified as belonging to the subacute group, particularly XIX, XXII, XXVI, and XXVII. Case XXV belongs to the acute group, perhaps best known to the surgeon. With increasing experience, we become more conservative in the management of these cases and have seen in the last few years, several in which we should ten years ago have unhesitatingly advised operation but in which a Fabian policy has resulted in recovery. Surprisingly serious infections of the kidney of this type will recover without operation.

Finally, we again call attention to the very intimate relation between this lesion of the kidney and perinephritic abscess. We believe it constitutes the etiological factor in the overwhelming majority of cases and that perinephritic abscess should always be suspected when these lesions fail to run a satisfactory course within a reasonable period.

Brief abstracts of the cases are appended in order to show the nature of the evidence.

ETIOLOGY KNOWN

CASE I.—Female, aged nineteen years. *Etiology.*—Defloration eighteen hours before present illness.

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Symptoms.—Abrupt onset, chill, fever to 105°, RCV pain, tenderness, spasm, right renal colic, frequency and burning on urination. *Duration.*—Pain and tenderness, ten days; fever, eight days; frequency and burning, fourteen days.

Laboratory findings.—White blood cells 18,000; urine 100 red blood cells and loaded with cocci. Urine became entirely normal in twenty-one days.

Result.—Excellent. Patient has since had normal pregnancy without "pyelitis of pregnancy."

Case II.—127886, female, aged twenty-eight years. *Etiology.*—defloration twenty-four hours before present illness.

Symptoms.—Sudden onset, chill, fever, dysuria, frequency and burning. Seen one week following onset. Physical findings normal. *Cystoscopy.*—Bladder showed blotchy inflammation. Left ureter specimen negative; right white blood cells, cocci, bacilli.

Laboratory findings.—Urine, 50 white blood cells, cocci and bacilli.

Result.—Symptoms and signs all cleared in two months.

Case III.—220733, female, aged fifty-five years. *Etiology.*—Chronic empyema with surgical drainage.

Symptoms.—Chill, fever to 104°, RCV pain, tenderness, spasm. *Duration.*—Pain and tenderness sixteen days; fever, twenty-one days.

Laboratory findings.—Blood cultures + staphylococcus aureus on tenth day. Urine culture, negative on third day. White blood cells 11,000. Urine, previous to present illness, negative. First day of renal infection, 100 white blood cells, cocci. Third day of renal infection, 200 white blood cells, cocci and colon bacilli. Tenth day of renal infection, 200 white blood cells, colon bacilli. Twenty-fifth day of renal infection, 100 white blood cells B. coli. Thirtieth day of renal infection, 50 white blood cells B. coli.

Case IV.—Male, aged ten years. *Etiology.*—Plastic on hand with wound infection one week.

Symptoms.—Abrupt onset, chill, temperature to 103°, RCV pain, tenderness and spasm, no urinary symptoms. *Duration.*—Pain and tenderness, seven days, fever, ten days.

Laboratory findings.—White blood cells 15,000; urine: cocci, few white blood cells; urine negative on fifteenth day.

Result.—Excellent.

Case V.—224874, male, aged eighteen years. *Etiology.*—Acute non-specific epididymitis (coccus) following upper respiratory infection, preceded his kidney infection five days.

Symptoms.—Abrupt onset, LCV pain, chill with fever to 101°, LCV tenderness and muscle spasm, frequency and burning on urination.

Duration of symptoms.—Pain, seven days; fever, three days; urinary symptoms, five days.

Laboratory findings.—White blood cells 15,000; urine: no white blood cells, loaded with cocci; normal in fifteen days.

Result.—Complete disappearance of all symptoms and signs in fifteen days.

Case VI.—237216, male, aged eighteen years. *Etiology.*—Boil on neck with coincident head cold, five days before present illness.

Symptoms.—Severe pain localized to right kidney; nausea; chills and fever. Persisting symptoms on rest in bed for fourteen days. Temperature septic type to 103° almost daily; never any urinary symptoms. Sixteenth day increase in all symptoms. Diagnosis of perinephritic abscess. Incision and drainage. Rapid and complete recovery.

Laboratory findings.—White blood cells 25,000; urine, repeated negative examinations until tenth day when several clumps of cocci were found; four cultures negative. Culture of pus negative.

Result of treatment.—Complete recovery.

CASE VII.—KB, 235640, male, aged twenty-seven years. *Etiology.*—Repeated catheterizations following herniorrhaphy.

Symptoms.—Chill, fever of 104°, followed in a few hours by acute severe pain in right kidney region. Examination showed extreme tenderness at this point; RCV muscle spasm.

Laboratory findings.—White blood cells 24,000; urine, occasional pus cell, no red blood cells, many cocci.

Result.—Afebrile, asymptomatic in five days; urine entirely negative in ten days.

CASE VIII.—154410, female, aged twenty years.. *Etiology.*—Removal of impacted molar twenty-four hours before present illness.

Symptoms.—Onset abrupt, LCV pain, tenderness and muscle spasm, temperature to 101°, slight burning and frequency at onset lasting ten days. Duration of symptoms ten days. Afebrile in five days.

Laboratory findings.—Urine, loaded with cocci, which diminished. On twelfth day urine showed few white blood cells, no cocci, many bacilli, which disappeared in ten more days.

Result.—Complete disappearance of all symptoms and signs within three weeks.

CASE IX.—152766, male, aged thirty years. *Etiology.*—Extraction of abscessed tooth twenty-four hours before present illness.

Symptoms.—Onset abrupt, acute LCV pain, tenderness, muscle spasm, temperature not known, had gross hæmaturia at onset, frequency and burning. Symptoms and signs completely disappeared in ten days.

Laboratory findings.—Urine, many white blood corpuscles, loaded with cocci (first seen five days after onset).

Result.—Complete disappearance of all symptoms and signs.

CASE X.—124646, female, aged twenty years. *Etiology.*—Acute tonsillitis.

Symptoms.—Abrupt onset RCV pain, tenderness, muscle spasm, no urinary symptoms, temperature to 101°. Duration of symptoms six days; of fever, three days.

Laboratory findings.—White blood cells 21,000; urine, a few cocci on first day. Remained in urine twenty-two days.

Result.—Complete disappearance of all symptoms and signs in twenty-two days.

CASE XI.—127988, male, aged thirty-six years.. *Etiology.*—*Cystoscopy*: for diagnosis of small right ureteral calculus; no infection in urine when first seen.

Symptoms.—Twelve hours following cystoscopy had chill, RCV pain, tenderness, muscle spasm, temperature 102°. Symptoms and signs increased for forty-eight hours and diagnosis of perinephritic abscess was made. *Operation.*—Three small cortical abscesses found in right kidney. Drained. Culture of pus, cocci. Uneventful recovery.

Laboratory findings.—White blood cells 11,000; urine: repeatedly negative; blood culture (twenty-four hours after chill) negative. Urine remained negative throughout.

Result.—Complete cure.

CASE XII.—132505, male, aged twenty-eight years. *Etiology.*—Upper respiratory infection.

Symptoms.—Abrupt onset, LCV pain, tenderness, muscle spasm, gross hæmaturia at onset lasting ten days, temperature 100°. Duration of pain, twenty-four hours; temperature three days.

Laboratory findings.—White blood cells 11,000; urine, gross blood, no pus, many cocci. Cocci in urine nineteen days, blood in urine ten days.

Result.—Complete cure.

CASE XIII.—134388, male, aged twenty-two years. *Etiology.*—Upper respiratory infection.

Symptoms.—Onset abrupt, RCV pain, tenderness and spasm. Some frequency and burning. Symptoms all subsided in eight days.

Laboratory findings.—Urine negative at twenty-four hours; fourth day 200 white blood cells/per low-power field, loaded with cocci; culture of urine positive for cocci; urine negative at fifteen days.

Result.—Complete recovery fifteen days.

CASE XIV.—211490, male, aged fifty-six years. *Etiology.*—Upper respiratory infection.

Symptoms.—Onset abrupt, chill with fever to 101°, LCV pain, tenderness and spasm, slight frequency. Duration of pain and tenderness three days; fever two days; frequency one day.

Laboratory findings.—Urine few cocci, which cleared up in five days.

Result.—Complete cure.

CASE XV.—220874, male, aged eighteen years. *Etiology.*—Upper respiratory infection.

Symptoms.—Onset abrupt, pain, tenderness, spasm, region of left kidney, nausea, no vomiting. Chills with fever to 104°, frequency, no burning. Tenth day (on admission) terrific left renal colic eight hours' duration. X-rays no stone. Left kidney enlarged, tender.

Laboratory findings.—White blood cells 20,000, urine 10-15 white blood cells/per low-power field, many cocci.

Cystoscopy.—? left hydronephrosis. Bladder negative, no obstruction or renal pelvis/residual found. Specimens: right negative; left, loaded with cocci. No pus.

Progress.—Fifteenth day symptoms and signs began to improve. Eighteenth day symptoms gone, kidney only slightly tender, no fever. Urine, few cocci and bacilli; no pus.

CASE XVI.—208504, female, aged twenty-six years. *Etiology.*—Acute tonsillitis.

Symptoms.—Abrupt onset, LCV pain, tenderness and spasm, 103°, frequency and urgency. *Duration.*—Pain, ten days; fever, 3 days; urinary symptoms, five days.

Laboratory findings.—White blood cells, 14,000; urine, negative at onset; few cocci third day; many cocci sixth day; twelfth day negative.

Result.—Cured.

CASE XVII.—202735, male, aged thirty years. *Etiology.*—Upper respiratory infection.

Symptoms.—Abrupt onset, RCV pain, bilateral CV tenderness and spasm, frequency, temperature and leucocytosis not known. Duration of pain, two weeks; urinary symptoms five weeks.

Laboratory findings.—Urine, no white blood cells, loaded with cocci. Urine gradually cleared, being normal in two months.

Result.—Cure.

CASE XVIII.—229553, male, aged eighteen years. *Etiology.*—Catheterization, postoperative.

Symptoms.—Chill, fever to 104°, RCV pain, tenderness, spasm. *Duration.*—Pain and tenderness, ten days; fever, ten days.

Laboratory findings.—White blood cells, 12,500; urine at onset, many cocci, no white blood cells; three days later, many cocci, 100 wbc/per low-power field; at fourteen days, cocci, bacilli, 200 wbc/per low-power field; at twenty-one days, rare cocci, many bacilli, 100 white blood cells; at forty days, few bacilli, occasional white blood cells.

Result.—Excellent.

CASE XIX.—219788, female, aged forty-four years. *Etiology.*—Cholecystectomy for cholecystitis and cholelithiasis four days before present illness. (Poor operative risk)

Symptoms.—Chill, fever to 103° at onset, general weakness, nausea and vomiting, abdominal distention, severe LCV, tenderness and spasm. All symptoms and signs increased progressively for fourteen days, signs shifting from one kidney region to the other. Patient in extremis for twenty-one days. Began gradually to improve at twenty-fifth day then on thirtieth day became much worse. Obviously bilateral condition per-

sisting. Septic temperature continues. At fifty-fifth day began to improve slightly having no chills from that day on. Gradual steady improvement; on seventy-fifth day discharged. Recent letter from patient (three months after discharge) states she is quite well.

Laboratory findings.—Repeated negative urines, pre-operative; at onset of renal infection—many cocci, no white blood cells; seventh day of renal infection—white blood cells, 200, cocci, bacilli; twenty-fifth day of renal infection—white blood cells, 200, occasional cocci, many bacilli.

<div align="center">ETIOLOGY UNKNOWN</div>

CASE XX.—225397, male, aged forty-three years. *Symptoms.*—Onset abrupt, severe RLQ pain with nausea, no vomiting. Twenty-four hours later RUQ and RCV pain with soreness in right testis. Slight urgency of urination. Fever to 102°. Chill with temperature to 104° on third day. Abdomen soft throughout. RCV tenderness and spasm. Tender along ureter.

Laboratory findings.—White blood cells 14,000; urine, no white blood cells, loaded with cocci.

Result.—Improved rapidly after fifth day. Fever gone on seventh. All symptoms gone on ninth day. Urine on eleventh day showed but few cocci.

CASE XXI.—216926, female, aged twenty-five years. *Symptoms.*—Abrupt onset, RCV pain, tenderness and muscle spasm. Frequency and burning. Temperature 99.6°. Duration of pain two weeks, fever two weeks, bladder symptoms one month.

Laboratory findings.—Urine (one week after onset) many white blood cells, loaded with cocci; one month later, no white blood cells, a few cocci.

Result.—Excellent.

CASE XXII.—199016, male, aged fourteen years. *Symptoms.*—Onset abrupt, entered hospital with diagnosis of typhoid on account of septic temperature and tumor in left flank thought to be spleen. *Examination.*—Extreme emaciation, severe LUQ pain, tenderness and spasm. X-rays negative for empyema so chest tapped, negative findings. Tumor in LUQ and flank was exquisitely tender. This proved to be left kidney.

Laboratory findings.—White blood cells 14,000; urine, many cocci, few white blood cells. Blood culture + cocci on one occasion following chill.

Progress and result.—Duration of pain, five weeks; of fever, four weeks.

Result.—Six weeks after admission was apparently entirely well.

CASE XXIII.—138227, male, aged twenty-one years. *Symptoms.*—RCV and RUQ, pain, abrupt in onset. RCV tenderness and spasm. Hematuria at onset lasting three days. Temperature 99.8° on third day. Duration of pain, six days; fever, two days.

Laboratory findings.—Gross hæmaturia; cocci which appeared in urine on fourth day. Culture: cocci. Urine negative after fourteen days. *Cystoscopy.*—Negative. Right specimen + cocci microscopic and culture. Left specimen — cocci microscopic and culture.

Results.—Complete recovery.

CASE XXIV.—139-52, male, aged thirty-eight years. *Symptoms.*—Abrupt onset, chills with fever, left CV pain and tenderness with spasm. Frequency and burning. *Cystoscopy.*—Bladder showed spotted inflammation. Duration of pain twelve days. Frequency and burning eighteen days.

Laboratory findings.—Urine (fourth day), many white blood cells and cocci in both ureter specimens ·+ cocci by culture and stain. Pus persisted in urine three months, cocci five months.

Results.—Complete recovery.

CASE XXV.—155404, male, aged fifty-six years. *Symptoms.*—Abrupt onset, chills with 103° fever, right renal colic and constant pain, tenderness, muscle spasm. No

symptoms on left. *Cystoscopy.*—Negative. Both ureter specimens + cocci by culture and by stain.

Laboratory findings.—White blood cells 24,000, urine, 200 white blood cells, loaded with cocci. Failed to improve eleven days. Operated, right kidney found to be large, purple, contained many pin-head-sized abscesses. Nothing done at operation. Patient died post-operative two days. No autopsy.

CASE XXVI.—157413, male, aged twenty-one years. *Symptoms.*—Abrupt RCV pain, tenderness and spasm, chills and fever to 105°, slight frequency and burning. Remained constant fourteen days then increased local signs. Diagnosis then made of perinephritic abscess and patient operated. Right kidney showed three moderate-sized cortical abscesses and perinephritic abscess localized medially. Culture of pus showed cocci.

Laboratory findings.—White blood cells 18,000; urine, few white blood cells, loaded with cocci; culture negative. *Cystoscopy.*—Before operation, bladder negative, right specimen cocci; left negative.

Result.—Complete cure by drainage of abscess. Urine became free of cocci in six months.

CASE XXVII.—218089, male, aged forty-nine years. *Symptoms.*—Bilateral CV pain, tenderness, frequency and burning, occasional chills and fever. Was up and about the entire period of his illness. Duration of pain, six months; frequency and burning, six months; chills and fever, off and on three weeks.

Laboratory findings.—Urine loaded with cocci; no pus. Refused treatment.

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VESICOVAGINAL FISTULA

By William E. Lower, M.D.

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It appears to be the opinion of some writers in these days of improved obstetrical methods that vesicovaginal fistulæ are becoming increasingly rare. Either that this is not the case, or that more attention is being directed to this unfortunate lesion, is indicated by the fact that the medical indices in 1916 showed only two articles under this caption, while in 1929 twenty-nine articles appeared.

The casualties of childbirth are still with us, but obstetrical accident is not the only cause of a vesicovaginal fistula; it may result from a surgical accident in the course of a pelvic operation; it may be due to malignancies of the bladder or cervix; or it may result from the application of radium in the treatment of a pelvic malignancy—to cite the most frequent causes.

It is perhaps not generally known, or has been forgotten by many, that the Woman's Hospital of New York was founded by Marion Sims solely for the treatment of vesicovaginal fistula, and that at that time, the incidence of the condition was so high that during the period from 1856 to 1861, he performed on an average of two operations a week for urethro-vaginal and vesicovaginal fistula, and in a report in 1867 he analyzed 275 cases of injury of the vesicovaginal septum!

Sims was by no means the first to recognize the seriousness of this condition or to attempt to cure it. Even Hippocrates refers to it. Paré recommended a method of treatment. In 1660 van Roonhyzen attempted unsucessfully to close a vesicovaginal fistula by suture, and from 1800 on, various procedures were recommended, some of which, in isolated cases, proved successful. But to J. Marion Sims, more than to any other surgeon, is due the credit for the development of a method for the exposure of the fistula and of a technic for closing it.

It is not necessary to describe Sims's operation nor the various methods and devices which have been proposed since his time by Kelly,[2] Frank,[3] C. H. Mayo,[4] Chute,[5] Roeder,[6] Young,[7] Legueu,[8] George Gray Ward,[9] and others. The important point is that the very variety of these methods emphasizes the fact that no one method is always reliable. This is emphasized also by the facts that in most of the cases that I have seen repeated attempts at correction have been unsuccessful, and further treatment has been made difficult by the presence around the opening of very hard, fixed scar tissue. It follows, then, that the treatment of a vesicovaginal fistula must be strictly individualized, the choice of method depending upon the position of the opening, its size, and the amount of cicatricial tissue that surrounds it.

One thing is certain—the surgeon should be prepared to bring to the aid

of the unfortunate women who are affected with this deplorable condition every resource at his command. The situation is rendered all the more tragic by the fact that the condition is rarely due to any fault on the part of the woman in whom it is present, but rather to circumstances of childbirth or of operation over which she has no control.

Etiology.—As stated above, a vesicovaginal fistula may be due to direct surgical injury, to an interference with the blood-supply of this area in the vagina and bladder by suture or by pressure of the fetal head, or to injury by forceps in the course of a delivery. According to Kelly,[2] the last-mentioned cause is rare, the danger being not from the use of forceps, but rather from too great delay in using them. A pessary may cause a fistula. W. L. Finton[10] has reported an interesting case of this type in which a retained contraceptive device called a "bee-cell" caused tension of the vaginal septum with resultant vesicovaginal and rectovaginal fistulæ, each two centi-
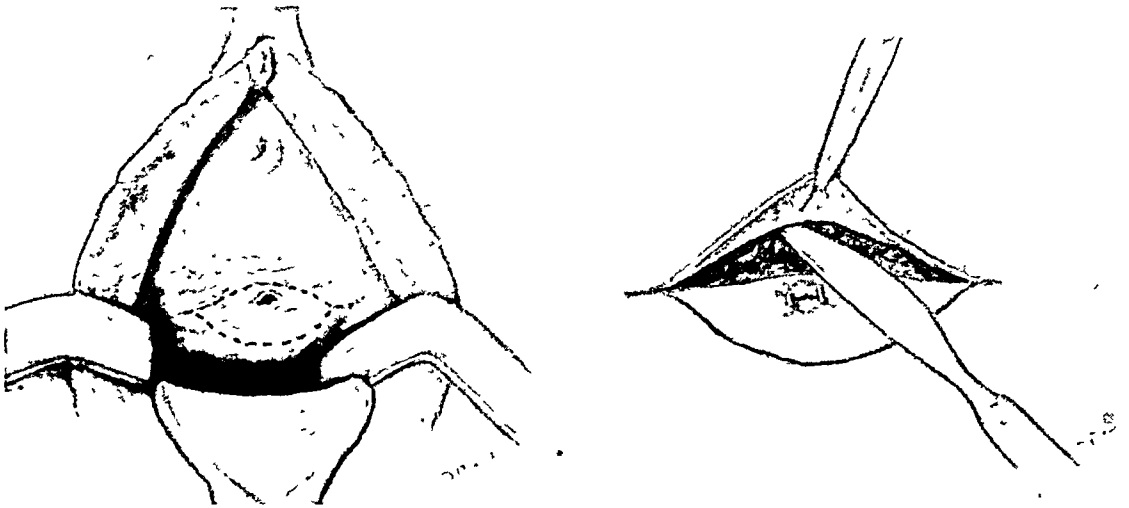
Fig. 1.—Operation for vesicovaginal fistula, Step I.

Fig. 2.—Operation for vesicovaginal fistula, Step II.

metres in diameter. Syphilis or cancer may destroy the vaginal wall, and Kelly adds the possibility of sloughing from a hematoma of the septum.

Incidence—I can find no direct references to the incidence of vesicovaginal fistulæ except that they are rare. I have already referred to the 275 cases reported by Sims in 1867. Bissell[1] reports that during the ten years previous to 1929, only fifty-eight patients were operated upon in the Woman's Hospital of New York for the repair of vesicovaginal or urethrovaginal injuries. This variation in numbers, however, cannot be taken as a true index to a lessened incidence, for in Sims's day few surgeons besides himself had directed their attention to the repair of vesicovaginal fistula, while today many surgeons understand the necessary repair. In my own practice I have had under observation thirty-two cases of vesicovaginal fistula, and have operated upon twenty-seven patients.

Diagnosis.—The diagnosis of vesicovaginal fistula presents but little difficulty. The principal symptom is incontinence of urine accompanied by excoriations of the vaginal mucosa. It should be borne in mind, however,

that in the case of a small fistula situated high in the vagina, most of the urine may be voided normally. In any case of incontinence of urine, especially if the patient has had deliveries or has been subjected to a pelvic operation, the vagina should be carefully examined to determine whether or not a fistula is present. In case of doubt, dye may be injected into the bladder, its appearance on the vagina indicating both the presence of a fistula and its site.

It is of special importance to determine whether or not more than one fistula is present, whether the cervix or the neck of the bladder is included
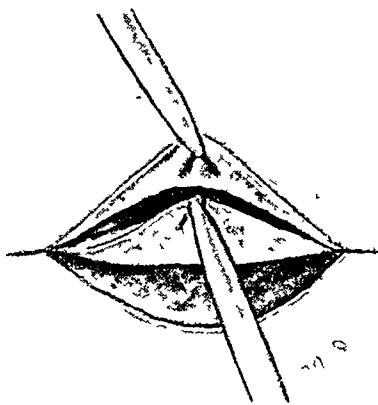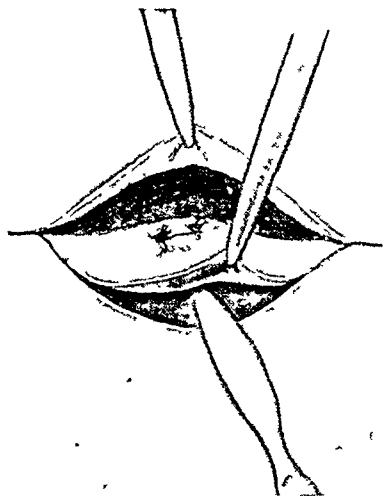
Fig 3 —Operation for vesicovaginal fistula, Step III

Fig 4 —Operation for vesicovaginal fistula, Step IV.

in the fistula, and whether or not a rectovaginal fistula also exists, as these findings have an important bearing upon the type of operation to be performed.

Treatment.—As before mentioned, the treatment for vesicovaginal fistula must be individualized, for while certain forms of technic which have been described by various authors have proved successful in some cases, they will not be successful in all cases. My own preference is operation by the vaginal route. A good exposure of the opening is essential. The parts should be thoroughly relaxed, and this is best accomplished by spinal anæsthesia. Early surgical intervention in cases of vesicovaginal fistula is important if primary healing is to be secured, unless the fistula is small, in which case it is safe to wait to see if it will heal without a plastic operation—simply by the use of an inlying catheter. To wait until much scar tissue has formed, or until there are considerable deposits of urinary sediment is to invite greater difficulty. If the first attempt to close the fistula fails, a second attempt should not be undertaken while the tissues are devitalized. A technic which has proved successful in the greater number of my own cases is here illustrated (Figs. 1 to 6).

Occasionally the opening is too great, or the tissues are so fixed that there is no hope of success from a local plastic operation. In such cases a ureteral

transplantation should be done. I performed a ureteral transplantation in one case in which at the first delivery the whole base of the bladder sloughed, and repeated local efforts to close the bladder failed. The ureters were transplanted into the rectum. The patient afterwards became pregnant and a living, normal child was delivered by Cæsarean section. This was seven years ago, and the mother and child are living and well.

I have performed forty-four operations on twenty-seven patients with vesicovaginal fistula. In fifteen of these cases repeated operations were performed before the fistula was finally closed.
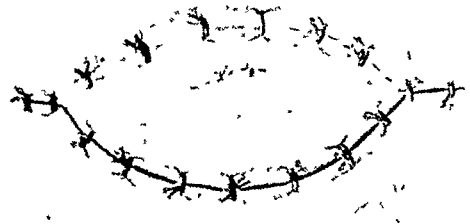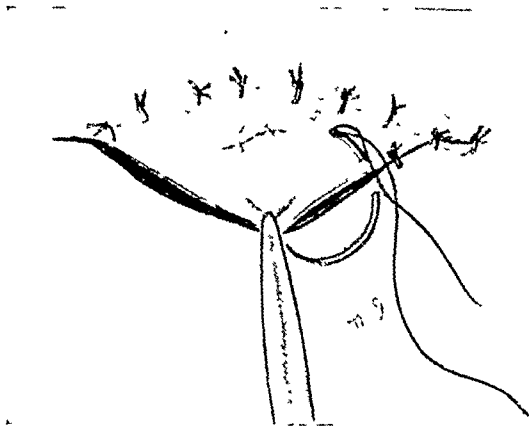
FIG. 5.—Operation for vesicovaginal fistula, Step V.

FIG. 6.—Operation for vesicovaginal fistula. Step VI.

Among the patients regarding whom we have been able to get follow-up reports, the results of operation have been completely satisfactory in 90 per cent. of the cases.

CONCLUSIONS

(1) Vesicovaginal fistula is probably the most distressing non-fatal condition that can occur in a woman.

(2) In severe pelvic operations, isolation of the ureters is important, and if the bladder or a ureter is injured, it should be taken care of at once.

(3) In the majority of our cases, operation by the vaginal route has proved to be the best method.

(4) No one type of operation suits all cases. Each case must be considered individually. By persistent efforts, most cases can be cured by plastic operation.

(5) If plastic operation fails, a ureteral transplantation should be done.

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PROGRESSIVE, GANGRENOUS, PAINFUL ULCERATION OF THE ABDOMINAL SKIN AND SUBCUTANEOUS TISSUES FOLLOWING OPERATION

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OPERATIVE wounds, even if infected, usually heal satisfactorily, but occasionally, especially about the abdomen, a stubborn, painful, ulcerating, gangrenous process attacks the surrounding skin, without involving underlying structures, and progresses indefinitely, resisting all ordinary treatment, until it is checked by more or less heroic surgical measures. This serious affection fortunately is rare, although perhaps more common than the literature would indicate. It is not mentioned in most text-books, and I have been able to find only five articles on the subject, describing but five cases. [See "Literature" at end of article.] All of these occurred in connection with suppurating wounds, mostly in operations for appendicitis, and in none of them was any general disease demonstrated, or any specific process, such as syphilis, tuberculosis, blastomycosis, *etc.*, which could with certainty be regarded as the cause.

The trouble begins a number of days after an operation, often a week to two weeks, and then not in the entire wound at once, but in some isolated portion, nearly always around a stitch-hole. A dusky redness of the skin at first appears, followed more or less rapidly by brawny induration, resembling a carbuncle, the color soon changing from red to livid and then black, as gangrene develops in the centre. In the meantime the red border of the lesion spreads slowly and irregularly, sometimes far in advance of the increasing induration and without relation to the distribution of nerves or blood-vessels. In the end, the affected area is not unlike a bad X-ray burn in appearance. (Fig. 1.)

The progress is not constant, showing exacerbations and remissions without apparent cause, and exhibiting renewed activity after temporary cessation. Large and small blisters frequently appear.

A characteristic feature is the severe, almost unendurable pain, which is mentioned by all writers. This appears early and is accompanied by exquisite tenderness; and although it may subside during a remission, it reappears with each exacerbation. It is so intense that individuals have been known to threaten suicide, and Christopher's[2] patient had to be anæsthetized when dressings were done. In my own case it was by far the most prominent symptom, reminding one of the pain of herpes zoster. Under its influence, aided by absence of sleep and appetite, patients lose flesh and strength rapidly and their morale is soon destroyed.

The course of the trouble is exasperatingly slow, lasting for weeks or

months unless checked by surgical means. There seems to be no limit to its progress. In Christopher's case the whole of the left side of the back, the flank and a portion of the anterior abdominal wall finally became involved, and it has been known to extend from the abdomen to the thigh.

A moderate rise in temperature, seldom over 102°, accompanies the early stages; but this soon disappears, or is reduced to a slight elevation, although it has a tendency to reappear at each exacerbation.

Suppuration is not an essential feature, although it usually is co-existent. It does not occur within the reddened or indurated tissues, and does not necessarily precede the disease. In my own case the wound had healed by primary union, the infecting agent apparently gaining access on the eleventh day through a stitch-hole, thus making it probable that in some instances, at least, infection takes place from without, rather than from the intestinal tract, as has been supposed.

The cause of this baffling lesion is unknown, unless we accept Brewer's theory, concurred in by Mayeda[5] and Shipley,[4] that it is due to a symbiosis of micro-organisms. Brewer and Meleny[3] succeeded in isolating two kinds of bacteria—a non-hemolytic streptococcus and a hemolytic staphylococcus. When one of these alone was injected into the skin of an animal, nothing of importance resulted, but when a mixture of the two was employed a gangrenous ulceration was produced. Although Brewer's experiments are interesting and suggestive, I am not aware that they have been substantiated by others. Although various organisms repeatedly have been found, none of them has been established definitely as a cause.

The extreme pain accompanying all cases would suggest a lesion of the nerves or their spinal ganglia, similar to that occurring in herpes zoster, if it were not for the fact that the local inflammation seems to precede the pain, although this would not preclude a nerve involvement secondarily. We are perhaps justified in assuming that a lowered resistance of the tissues may play a part, as in noma, perhaps due to trophic disturbances or to some other more or less general factor.

In this extraordinarily stubborn disease all ordinary methods of treatment, including multiple incisions (Brewer), have been useless. Mayeda,[5] for instance, systematically tried many things without success. He lists them as follows:

1. Powders—iodoform, dermatol, yatren, *etc.*
2. Salves—boric acid, pythylol, orthoform, zinc oxide, belladonna, *etc.*
3. Fomentations—boric acid, sodium chloride, rivanol, bichloride of mercury, potassium permanganate, pyrozone, *etc.*
4. Baths—potassium permanganate, lysol, sodium chloride, *etc.*
5. Continuous irrigation—rivanol, pyrozone, sodium chloride, *etc.*
6. Injections into surrounding infected tissues—rivanol, carbolic acid, oxygen, *etc.*
7. Local steam-douches.
8. Local use of X-ray, artificial sunlight.
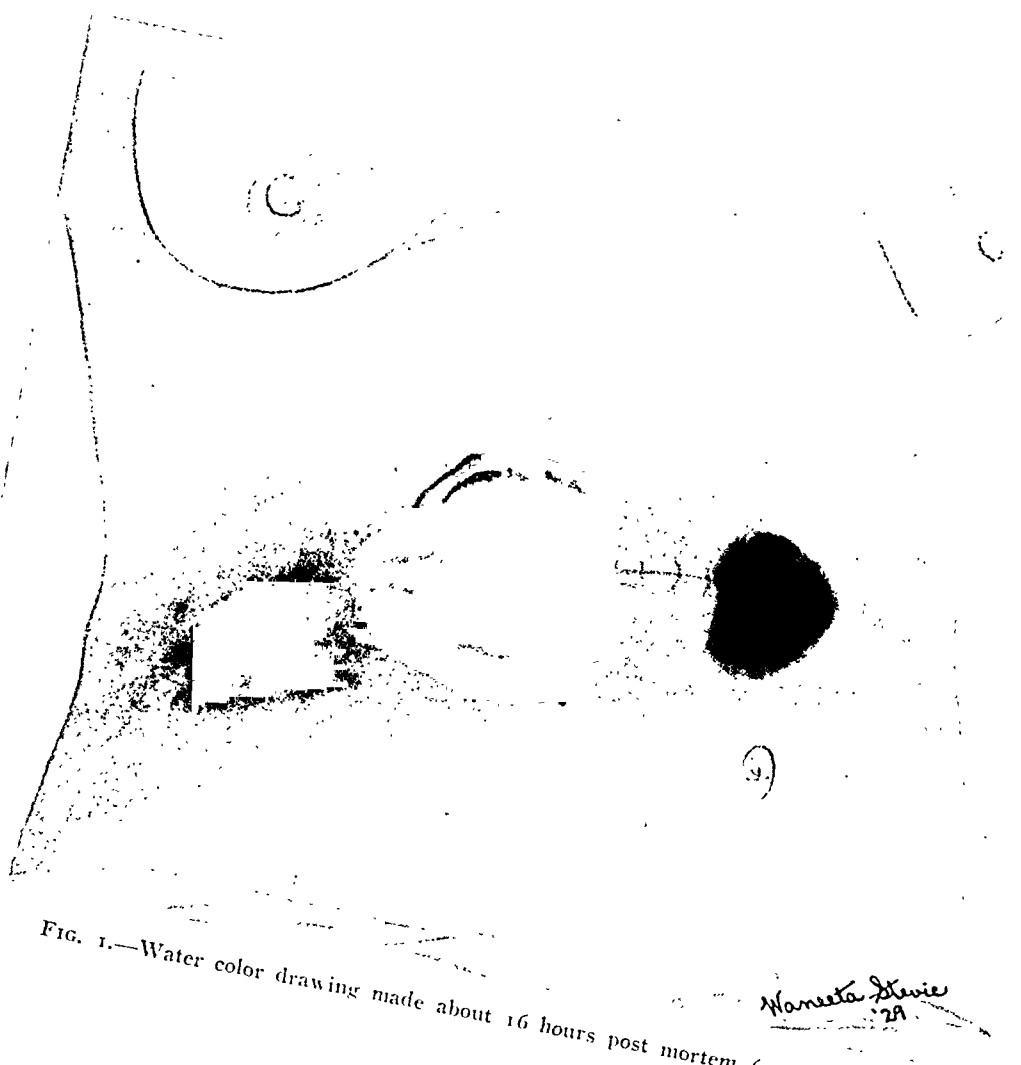
FIG. 1.—Water color drawing made about 16 hours post mortem (author's case).

9. Intravenous injections—calcium chloride, salvarsan, glucose, sodium chloride, *etc.*

10. Vaccines—colon Bacillus, staphylococci, streptococci.

11. X-ray applied to spleen.

12. Injections of proteins—patient's own blood and serum, horse-serum, human serum, *etc.*

13. Internally—yatren, potassium iodide, *etc.*

The only way to check the relentless spread of the trouble seems to be the use of the actual cautery, and nearly all those who have reported cases have had to resort to this in the end. In order to accomplish anything it is necessary to go well beyond the red margin, into sound skin, burning a gutter down through the subcutaneous tissues. In addition, the entire diseased area may be cauterized, although Brewer obtained satisfactory results by packing the gutter with gauze saturated with 1 per cent. formalin. Excision with the scalpel is perhaps inadvisable on account of hæmorrhage and the danger of re-infection. The results of such operations have been immediate and gratifying, although earlier diagnosis and cauterization undoubtedly would improve them. Skin grafting may be done later on, but healing may take place spontaneously, especially when islands of undestroyed skin remain.

CASE HISTORY.—A well-developed and well-nourished woman, thirty-nine years of age, with a tuberculous family history. Two operations had been performed a number of years previously; one upon the uterus and tubes, which was followed by pneumonia and erysipelas; and another an induced abortion, followed by an almost fatal acute nephritis.

For a year or more she had suffered much with the ordinary symptoms of chronic cholecystitis, gall-stones being revealed by the X-ray. The urine was negative, erythrocytes 4,420,000 and hæmoglobin 81 per cent.

March 27, 1929, through a transverse incision, a cholecystectomy was done and an obliterating appendix removed. The wound was closed without drainage. The superficial stitches were removed on the ninth day. There was satisfactory healing of the wound with no signs of inflammation. Several deep "button-sutures" were permitted to remain in place, there being no cutaneous reaction.

On the eleventh day the patient was permitted to get out of bed, her temperature being normal and her condition satisfactory; but in the afternoon the temperature rose to 101°, accompanied by headache and general malaise. Nothing abnormal was then observed in connection with the incision.

On the twelfth day a severe burning pain developed in the wound, extending around the flank towards the spine, and on removal of the deep sutures one of the stitch-holes exhibited redness and irritation and seemed to be the centre of the discomfort. From this time on the skin surrounding the wound, to a distance of about two fingers' breadth on either side, rapidly became swollen, indurated, dull red in color and exquisitely tender, like a great carbuncle, while the burning pain increased in intensity until it was almost unbearable. During the next two weeks the inflamed area slowly turned livid in color; and at the end of about three weeks was black and frankly gangrenous, the slough being dry and leathery. The whole area somewhat resembled a severe X-ray burn. At no time was there an abscess present or other evidence of either deep or superficial suppuration. The process did not extend to the underlying parts, but confined itself to the skin and subcutaneous tissues.

The treatment, outside of general measures, consisted at first in the application of

warm boric-acid fomentations. Later various ointments and solutions were employed, but without effect.

As soon as the gangrene was complete and the sloughs cut away with scissors the pain largely disappeared, although the patient was left exhausted and anæmic. The highest temperature (102°) was on the sixteenth day. After this it slowly declined to 99° and 100°, where it remained.

Following the development of gangrene there appeared to be a short remission of the process; but soon it began to extend again, the skin slowly becoming red far beyond the original incision clear around to the spine on the right and several inches past the median line on the left, there being little extension longitudinally. The redness far outstripped the induration, which usually, but not always, followed later. The progression was at no time serpiginous, as has been noted in other cases.

About four weeks after the onset of the trouble, although the urine previously had been negative, a nephritis developed, accompanied by œdema, particularly of the right arm, face and neck, and on May fifteenth death took place from uræmia, the disease having ceased to advance shortly before that time. The intention was to have excised the entire lesion with the actual cautery, but this was prevented by the critical condition engendered by the nephritis.

After death the red area of skin retained its color unchanged, as shown by the accompanying drawing, which was made about sixteen hours post-mortem (Fig. 1), thus indicating, perhaps, the hæmolytic action of the microbic cause, which, however, could not be determined from among a confusing multitude of micro-organisms.

Dr. C. E. Tennant, of Denver, kindly permits me to mention an unpublished case of his. The trouble followed an operation for ventral hernia done in 1925 on a woman of sixty-four. It appeared in a stitch-hole on about the eighth day, manifesting itself by marked redness and induration, but no suppuration, the wound having healed primarily. The progress was rapid, the skin quickly becoming livid and then gangrenous, intense pain being always a predominant feature. The lesion, which was in the right hypochondriac region, finally attained a size of about six by nine inches, reaching well across the median line and involving the skin and subcutaneous tissues, but not the muscles. The highest temperature, 102°, was reached within a week, but it soon dropped to about 100°, where it remained indefinitely. A Wassermann test was negative, as were also the urinary findings.

In the treatment, all sorts of antiseptics were tried without effect, but by the industrious use of artificial and direct sunlight the disease finally was arrested at the end of four months. After several ineffective attempts at skin grafting, cicatrization took place spontaneously, but the woman never recovered her terribly shaken morale and committed suicide within a year. The original operation was a cholecystectomy, and Doctor Tennant has always been inclined to connect the progressive gangrene with hepatic insufficiency.

Cole and Heideman[6] report a typical case in which the trouble started in a stitch-hole of a stay-suture seventeen days following a drainage operation for appendicitis. There was the usual intense pain, tenderness, brawny redness, gangrene, stubborn persistence and extension of the process, in spite of all treatment, until it was finally checked in about five months by the use of the actual cautery, after it had involved a large portion of the skin of the abdomen.

In spite of the fact that there was no history of dysentery, and emœbas could not be found in the appendix, the authors felt that the trouble was amœbic in origin, because they found the organism in the pus and tissues, and the progress of the disease seemed to be slowed by the injection of emetin. Further observation is necessary, however, before accepting this conclusion.

POST-OPERATIVE PROGRESSIVE SKIN ULCERATION

SUMMARY

A rare wound-infection is described, occurring principally, but not always, in connection with abdominal incisions.

It begins usually in a stitch-hole a number of days following an operation and spreads slowly and indefinitely, causing marked induration of the skin, which is at first red, then livid and finally gangrenous. The process is accompanied by intense pain and tenderness and moderate fever, and may last for weeks or months, causing great physical and nervous exhaustion and possibly resulting in death.

The cause is obscure, although an amœba has been suggested by Cole and Heideman, and the symbiotic action of a streptococcus and a staphylococcus by Brewer and Meleny.

It usually has been found in connection with suppurating wounds, but in the writer's case it began in a stitch-hole, following primary union of a gall-bladder incision without drainage.

All ordinary methods of treatment usually have failed, the only effective remedy being the heroic use of the actual cautery.

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DISCUSSION: DR. J. SHELTON HORSLEY, of Richmond, Va.,: I have had one case, not exactly similar to Doctor Freeman's, but it apparently came from the same cause. It followed an operation for intestinal obstruction on a man about sixty-five years of age. It was due to an intussusception from a lipoma in the submucosa of the ileum. After removing the cause of the obstruction, the bowel was very much dilated and I did an oblique tube enterostomy. There was so much distention that the original McBurney incision was supplemented by a rectus incision, running up the right rectus muscle and so turning up a triangular flap. The patient made an immediate satisfactory recovery. There was some infection of the wound, then gangrene started in the angle of the incision. This spread in the direction of the right side, following in a general way the nerves and vessels and involving the adjoining tissues. It was not particularly painful. Finally, after about a week or ten days there developed a gangrenous mass including not only the skin but the whole thickness of the abdominal wall from near the mid-line up

to the lumbar region. It was obvious that the intestines would break through, for they were held back by very flimsy necrotic tissues, so I excised the whole gangrenous area with an electric cautery, leaving a large amount of intestines with very few adhesions exposed. Temporarily, to stop the defect, I put in a piece of rubber inner tube from an automobile tire, knowing that rubber is not very irritating to tissues, and sutured it with mattress sutures, and left that for a week. In the meantime the section of rubber had stimulated adhesions and exudate and after about a week it was removed. Then a flap was outlined from the skin above and in stages transplanted over the defect, leaving, of course, only the skin and subcutaneous fat and fascia. After a series of operations the wound healed satisfactorily. He wears a support and gets along fairly well with it. Of course he has no actual musculature support. The interesting thing is that all of the abdominal wall was involved in the gangrenous process from the skin down to and including the peritoneum. It was not painful and it was promptly checked by a rather thorough eradication with the electric cautery. This case is reported in full in the Archives of Surgery for March, 1929, vol. xviii, pp. 882-891.

DR. EMORY G. ALEXANDER, of Philadelphia, recalled a case which he reported several years ago before a joint meeting of the New York Surgical Society and the Philadelphia Academy of Surgery. Doctor Brewer incorporated this case in his report of a similar condition which he reported before this association. The condition followed an operation for an appendiceal abscess and was quite typical of what Doctor Freeman has described. Two or three weeks following the operation the trouble began around an infected silkworm-gut stitch; the infection traveled outward to the crest of the ilium, thence downward over anterior and lateral aspects of the thigh to the knee; this infection seemed to travel in waves of about three weeks' periodicity. Dr. Jay Schamberg, of this city, saw this patient in consultation and he termed it a gangrenous dermatitis and stated that he had seen similar conditions in smallpox. Doctor Brewer was working on an anaërobic organism that he thought probably might be the causative factor. In this case we tried every sort of antiseptic. None seemed to be of any avail. Very little benefit was derived from heliotherapy. The condition finally burned itself out and the patient recovered.

DR. MAX BALLIN, of Detroit, Michigan, said that within the last year he had seen four such cases of post-operative gangrene.

As to the location of the gangrene, this can happen almost anywhere in the body where a draining wound exists.

The first one of his four cases concerned a boy eight years of age. The gangrene developed about the incision for drainage of an inguinal gland abscess. The process in this case lasted twenty-two months until healing was established.

The second case was very similar to Doctor Freeman's; it followed the drainage of a case of gangrenous appendicitis, and recovered within thirty days after onset.

The third case followed in a fistula from a thoracotomy for empyema. The picture of this gangrene was very much like the picture in the case published by Christopher, of Chicago. The gangrene lasted ten months before it healed.

The fourth case developed in a fistulous tract resulting from an abscess of the epididymis breaking through the scrotum. Also here, the typical undermining of the skin and the serpiginous cutaneous edges were present as in all other cases. In contrast with this rather dry and slow form of gangrene is the moist, rapid, very fatal gangrene of the scrotum originating from intestinal anærobes coming from a pararectal abscess or breaking through of a suppurative diverticulitis of the sigmoid into the scrotum.

As to the treatment of the gangrene under discussion, Shipley's proposal to recognize these cases early and then to remove the whole gangrenous area by excising it with the electro-cautery knife, is the proper method. This can be followed in a very few days, less than a week, by skin grafting. In this way he succeeded in bringing the post-appendiceal case to a cure in thirty days; the scrotal gangrene healed in two weeks following the cautery treatment, after the process had existed from three to four months previously.

All serum and different light and antiseptic treatments are usually of no avail and merely allow the progress of the affection.

STUDY IN POST-OPERATIVE BLOOD CHEMISTRY

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Following an ether anæsthesia and a surgical operation the patient generally lies for twenty-four to forty-eight hours in an exceedingly depressed condition which is very difficult to describe accurately. Nevertheless, it is a rather clear-cut clinical syndrome. I am not speaking here of those cases of frank shock or collapse due to extensive traumatism, infection or hæmorrhage. I wish to rule out those cases of definite post-operative complications including frank infection or starvation acidosis and our studies concern simply that state in which all patients return from the operating room and remain for variable periods of time. We may well use the term "post-anæsthetic sickness" as used by Mackenzie[1] in a recent paper.

As stated above, this condition does not present any clear-cut clinical symptoms. However, our patients are all profoundly depressed, even after the effect of the anæsthetic has apparently worn off. They are very weak; the pulse is often slow; the skin is cold and pale. They are unable to retain food or water and do not respond normally to external stimuli. The condition corresponds rather closely with that of the after-results of a severe alcoholic intoxication, and of course the "hang-over" following a "spree" would naturally be expected to bear a close resemblance because of the very similar pharmacological effects of alcohol and ether. The following studies are an attempt to analyze the various factors in this condition by careful studies in blood chemistry, to evaluate their importance, and perhaps to suggest methods of therapy.

Experimental.—The experiments undertaken were studies on normal human and animal organisms of the effect of operations of moderate severity. Only individuals were chosen who were normal or practically normal to begin with; that is, at least patients who were not toxic or acutely ill at the time of operation, so that their pre-operative condition could be used as a control in the blood chemical studies. The cases studied included hernias, individuals with cholelithiasis who were operated on during afebrile periods, and in the absence of jaundice and pain, hysterectomies and appendectomies, also operated on during intervals between attacks. The two appendectomies in the charts were difficult cases complicated by adhesions in which considerable trauma was necessary to get the appendix out. These cases were kept under continual observation for twenty-four to forty-eight hours by one of us and specimens of blood were drawn at very frequent intervals, as is illustrated by the curves. No special after-treatment was instituted and in no case was any medication given which would be likely to affect the blood

chemistry to any great extent. In fact, occasional doses of morphine were the only medication permitted. In no cases were normal salt solution or glucose given either rectally, subcutaneously or intravenously, and there was in most instances a practically complete starvation both as to food and water for twenty-four hours. At the end of twenty-four hours in those cases in which the studies were continued beyond that, practically negligible amounts of water and fruit juices were given by mouth. The details of each experiment are given in the subtitles of the charts.

Shock.—The condition of post-anæsthetic sickness is frequently described as post-operative shock, but the most cursory analysis of our charts shows clearly that shock in its modern conception is most certainly not present in these routine cases. A definition of shock today is difficult to give and it is classified under various heads. Whether we accept Crile's[2] conception of "a depression of the vital cerebral centres due to an excessive stimulation and resulting in a vasomotor paralysis," or the older concept of an exanguination into the portal system, one must admit that in its broader scope shock is characterized by a fall in blood-pressure. This feature was conspicuously absent from all of the cases studied by us, where careful blood-pressure estimations were made at very short intervals. Besides this absence of a fall in blood-pressure it will be perfectly obvious from an analysis of the patients operated on and the extent of surgery undertaken that, whereas a fall in blood-pressure during an operation may be more or less significantly great, a prolonged low blood-pressure during the following day is rather rare.

The next important criterion of shock is an elevation of the pulse rate, and not only our own charts here, but common clinical observation tells us that this does not take place. In fact, the opposite is more often true and the pulse in the post-anæsthetic period tends to run lower than normal. The above observations, we believe, make it impossible to set the term "post-operative shock" as having any meaning in anæsthetic sickness.

Cannon's[3] theory of shock, that is, the absorption of toxic material from traumatized tissue, has received an interesting confirmation in the hands of Buerger and Grauhan.[4] The latter authors have demonstrated a constant rise in the non-protein nitrogen in the blood during the first week following an operation. They are at a loss to explain this phenomenon occurring at a time when the intake of nitrogen is practically zero on any other basis than as the breaking up of protein material most likely from the operative field. While one might not wish to go so far as to agree with the latter authors that this is "direct proof of the presence of the product of protein disintegration in the blood-stream," the assumption is at least to be considered and we believe it is quite suggestive in view of the changes in the blood calcium and permeability to be reported later.

Acidosis.—Frequent claims have been made that acidosis is a prominent feature in post-operative toxæmias. Our studies have shown that this was a totally unwarranted assumption and in all of the cases which were studied intensively both the carbon dioxide combining power of the blood serum as

determined by the Van Slyke[5] method and the blood chlorides[6] determined at almost hourly intervals showed no fluctuation which was outside the limits of normal. In most cases the two ran fairly parallel to each other. This was not the invariable rule by any means, the minor fluctuations of the two curves occurring quite independently of each other. While, in general, there is a slight trend toward the acid findings in the post-operative period, it is very slight indeed, and in many cases an actual rise occurs in the carbon dioxide and a fall in chloride probably brought about by small amounts of emesis, although no cases are reported in this series where the emesis was profuse and frequent enough to bring about an alkalosis. The latter, of course, is a perfectly definite syndrome which is clearly understood and whose symptoms are quite different from the ordinary post-operative course.

It may here be noted that such a condition (acidosis) might well have been a feature a few years ago when it was the custom to starve patients before operation and even to deprive them of the normal intake of water. Such is not the case now. In our clinic, at least, the patients are encouraged to take large quantities of water up to a few hours before the operation, and the patient's normal supper is not only allowed but insisted upon the night before the operation, special provision being made to give an adequate supply of carbohydrates the day before. Thus, while it is possible that some of the early work reported on post-operative acidosis has a real foundation, it is obvious that it does not occur in patients that are neither starved nor dehydrated. Besides the curves here given of the intensive blood chemistry studies, we can back up this assertion by a large number of random CO_2 estimations made post-operatively at varying periods. Acidosis of high degree does not occur post-operatively except as a special complication brought about by prolonged dehydration or prolonged starvation due to inability to retain food, and such complications occur practically always in operations on the intestinal tract in which starvation is necessary, or in patients arriving on the operating table in the condition of acidosis to begin with. In our experience, the carbon dioxide combining power is, in most cases, a far more serviceable index than the blood chlorides as the latter are considerably more variable. This is probably due to the derangement in the gastro-intestinal tract. There is no such compensatory mechanism available for the chlorides as there is for the carbonic acid radical. Excess of carbon dioxide may be breathed out in the lungs and the plasma bicarbonate with its buffer action mechanisms tend to maintain a more or less constant p^{II}. The chlorides, of course, are not volatile and form firm compounds with bases. Such a mechanism is impossible. A secretion of hydrochloric acid to the stomach such as may occur under slight digestive stimuli will produce marked changes in the blood chlorides as will, of course, the absorption or failure to reabsorb chloride ions from the gastro-intestinal tract, which we know is in a most unstable and disturbed condition during the post-operative stage.

Studies of the normal have shown that deprivation of food and water for the periods here considered will not bring about a clinical acidosis in normal

individuals. The buffer action of the plasma bicarbonates is ample to compensate for this length of time and maintain an approximately normal p^{H}.

Blood sugar.—It is well known that the effect of ether on an organism is to produce a marked rise in the blood sugar. This is probably due to liver injury and resulting outpouring of glycogen. If ether narcosis be induced in a dog for two to three hours, the blood sugar will rise to over 200 in many cases and glycosuria be produced. In man, the effects of exceedingly prolonged ether narcosis are similar but generally not so intense and glycosuria is rare, although, if it be watched for carefully, it can occasionally be discovered, if the first specimens following the operation are tested. There were no such severe cases of increase in our series, all of the operations being concluded in an hour or less, and in such cases the hyperglycæmic condition is much less marked, although it is practically always present for a few hours after the completion of the operation. But it tends to return to normal fasting levels by about the end of the sixth hour.

We know, of course, that this high blood sugar never reaches toxic levels, but there has been considerable literature of late as to the possibility of hypoglycæmia being a feature of post-operative conditions. The sugar metabolism post-operatively has been discussed at length by us in a previous paper[7] and the conclusion arrived at that the blood sugar level does not fall low enough in the routine case to require any therapy. In our patients who, as mentioned above, receive ample food before operation, there is never any fall in blood sugar sufficient to lead one to consider such hypoglycæmic toxic condition. It has been shown by one of us that in animals and human beings who are œdematous, blood sugar tends to run higher and the effect of insulin injections is much less.[8, 9] The evidences of tissue thirst found in our series of Aldrich intradermal salt tests seems to us to point to a slight subœdematous condition, and one is lead to assume that the allocation of water in the tissue is the explanation at least in part of our failure to find low blood sugar. In fasting studies of metabolism it has been repeatedly shown that it is only when the terminal stages are reached that the blood sugar falls appreciably below the normal fasting level such as one finds between meals.

Infection.—There has been an assumption frequently made that minor degrees of sepsis arise in the wound rather frequently although no actual suppuration takes place and the body overcomes the infection and the wound heals normally. It has been said that many bacteria make their way into the organism and that such a degree of sepsis is a factor in many post-operative conditions. The best indices that we have for infection are the number of leucocytes and the temperature. In our cases, the leucocyte count was, as a rule, slightly higher than normal, but under no circumstances were there fluctuations which were large enough to be interpreted as indicative of sepsis. Modern investigation of the mechanism of leucocytosis by Mueller[10] and others has shown clearly that the number of leucocytes in the circulating blood is far from a constant matter. Rapid fluctuations will be found in most cases if counts are made at very short intervals and these fluctuations

are dependent on stimuli of a wide variety of types. Disturbances of the autonomic and sympathetic nerve balance as shown by Petersen[11] produced profound leucocytic changes. These probably work through a mechanism of balancing of the peripheral and visceral vascular beds and are related to both the temperature and the body activity as has been suggested by the work of Cannon and the further experiments of Mueller and Petersen[12] on changes produced in chills. Furthermore, as Petersen and Boikan[13] have shown, the leucocytic and temperature reaction to infection takes place, not at the time of entry of the organism into the blood-stream, but later, after an hour or two, when they are taken up in the reticulo-endothelial system and begin to bring about bodily changes then. The fact that the so-called fibrin fever gives much more of a leucocytosis than a temperature change can be demonstrated quite clearly by the injection of sterile blood. The fact of profound changes in the leucocytes brought about by foreign protein injection is well known and takes on some of the characteristics of foreign protein and it is not at all surprising that the fluctuations of minor character as noted on our charts would occur from such a stimulus.

The temperature after an operation also tends to fluctuate considerably, as the paralysis of the vegetative nervous system renders the organism partially poikilothermic. These fluctuations are of a minor degree only, however, and there is a tendency in the latter part of the twenty-four-hour period to find a slight fall in body temperature, which is probably due to evaporation of water from the pale, clammy skin and can be combated by careful nursing. It has often been pointed out that profound fall in temperature may take place during such a vasomotor paralysis if external heat is not applied or at least attention paid to the maintenance of bodily heat by warm covers. In view of the above, the changes of the leucocytes or the temperature are not of such high grade as to warrant the assumption of any infection occurring.

Dehydration.—As stated above, our patients were provided with an ample supply of water before operation 'and dehydration to an important degree does not occur. The protein concentration of the blood was measured by the refractometer. (After reading the refractometric index, the protein concentration can be calculated from Reiss's tables.[14],[15] This protein concentration affords a rather accurate means of estimating the fluid content of the blood. As can be seen from the accompanying charts, fluctuations of considerable degree take place but are always within the range found in normal individuals. This fluctuation is most marked in the earlier stages as evidenced in Charts 1 and 2, which show that there tends to be a slight concentration of the blood following a slight transient fall in the first few hours. This is apparently due to the fact that the patients have lost a *moderate* amount of water in the urine and sweat before they have been able to absorb much in the stomach. However, it is not to a degree which could be considered pathological. It is interesting here to note that these changes in the concentration of the blood cannot be profoundly influenced merely by administration of fluids.

With these points in view a series of studies was made by means of the Aldrich-McClure intradermal salt test[16] (see Chart 9), that is, the length of
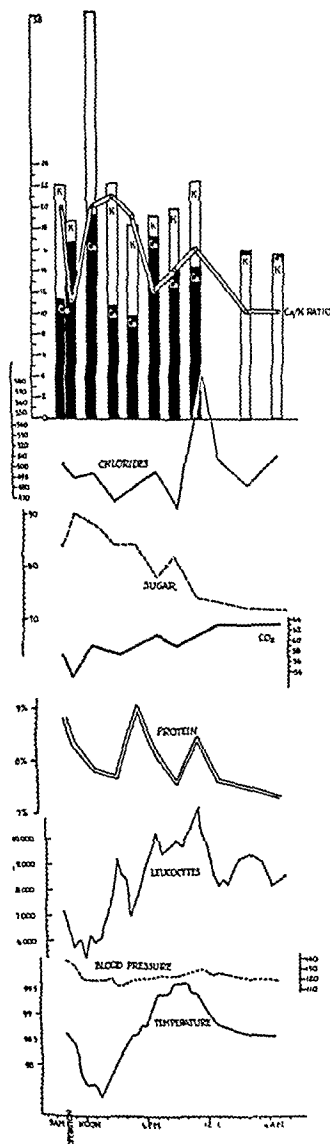
CHART 1. — Interval appendix case. Observations extended from time of operation, 10:00 A.M., continuously until 6:00 A.M. the next day. This was a very difficult case in which McBurney's incision was first made and it had to be very much enlarged. The appendix was dug out of a dense inflammatory mass of old adhesions. The post-anæsthetic sickness was very marked.
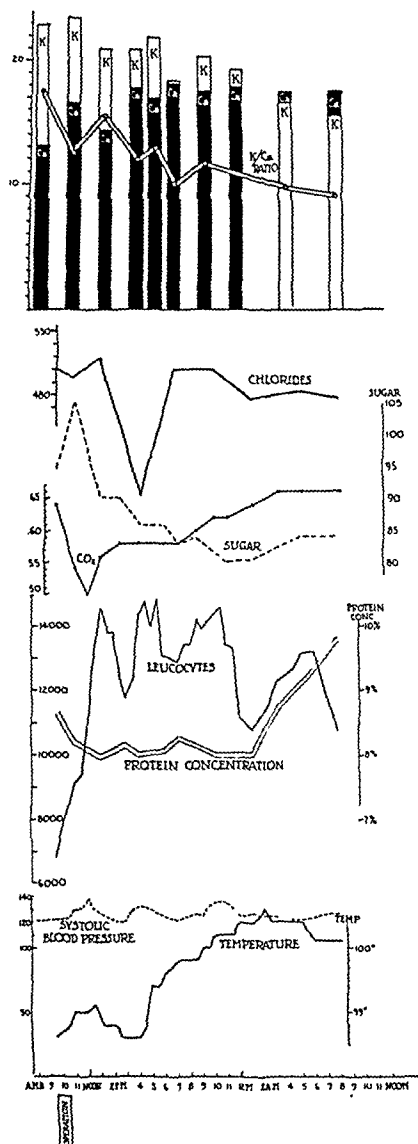
CHART 2.—Subacute appendicitis. Operation through a right rectus incision large enough to admit exploration of the gall-bladder and the uterine adnexa. Observations extended from before the operation until 8:00 the next morning. Post-anæsthetic sickness moderate, but patient felt very badly at the time the observations stopped.
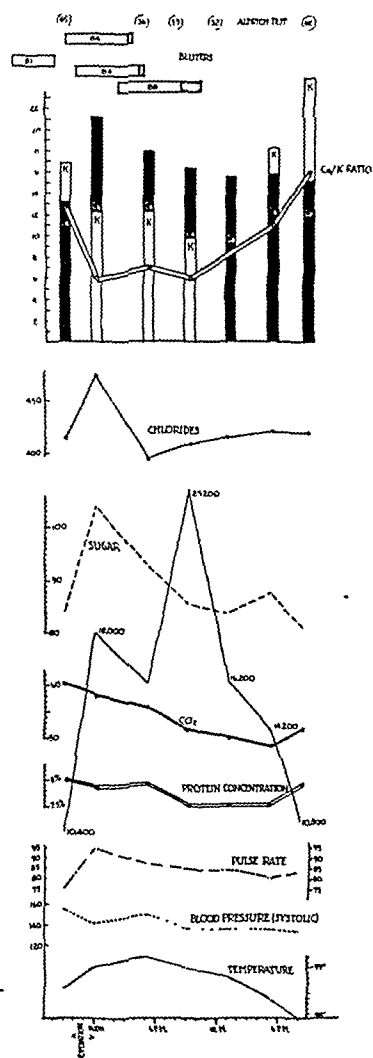
CHART 3.—Excision of inflamed gall-bladder with stones. An uncomplicated cholecystectomy. Operation consumed only 45 minutes. Observations continued until 8:00 P.M. of the day after the operation, nearly 36 hours. Post-anæsthetic sickness was very marked the afternoon and night of the first day, but by noon the next day the patient felt unusually well, for a cholecystectomy case. Note the return of K-Ca values in the blood towards normal the evening of the first day post-operative, corresponding with the improvement in the patient's general condition.

absorption time of an intradermal wheal made by the injection of normal salt solution. This test may be looked upon as an index of tissue thirst, or, the avidity with which water will combine with the proteins of the blood and

the tissues to remain held in fixation by them.[17] In practically every case, while there still appears to be approximately normal amount of water in the body or at least in the blood as measured by the refractometric index, there

is a marked change in the Aldrich time. It is constantly lessened, indicating an increase in the tissue thirst. It is seen that the colloids become more hydrophilic and tend to hold the water in fixation even in the absence of acidosis, so that the phenomenon cannot be explained simply on the basis of Martin Fischer's theory of œdema. This occurrence is indicative either of changes in the protein complex itself or of surface tension changes, and probably bears a close relation to the changes in the mineral salt balance to be described below.

Blood calcium and potassium ratio.—Estimations of calcium and potassium were made by the method of Kramer and Tisdall.[18, 19] This was done on seven cases, on three of them at very short intervals (see Charts 1 to 7), and also on three dogs (see the composite Chart 8). In all cases there was the most astonishing change in the mineral salt balance persisting about twenty-four hours. In every case there was an enormous rise in the calcium in the blood accompanied in all severe cases by an equally large fall in the potassium. This was so marked that the ratio, instead of being about 2 to 2½ fell to below 1 on five occasions. In addition to this, a series of three dogs was run in two of which cholecystectomies and in one of which a gastroenterostomy were done under ether anæsthesia. Beginning immediately after the operations blood was drawn at short intervals for calcium and potassium determinations. In each of the experiments the same condition was noted to somewhat the same degree. Examination of Charts 5 and 6 will show the changes in mineral salts of a lesser degree. These patients underwent more or less trivial operations of very short duration in which only minimal amounts of ether were administered. It will be seen that in each case there is a marked rise in the calcium but the compensatory mechanisms of the body have kept the balance fairly regular by corresponding rise in potassium. In neither of these cases was
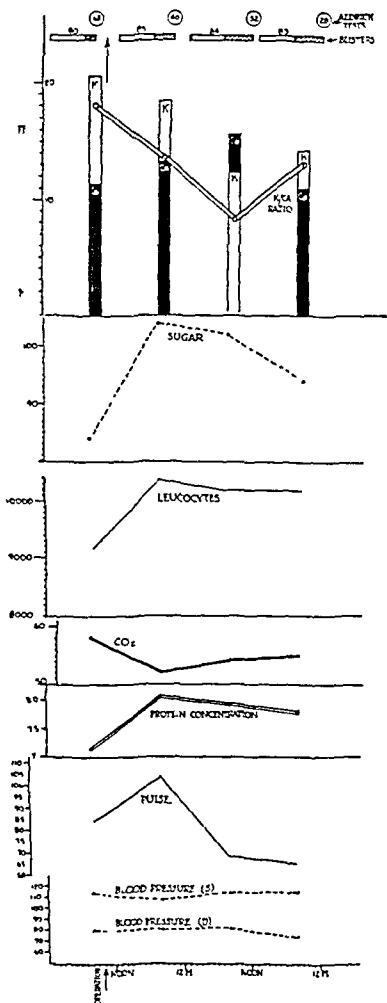
there any evidence of post-anæsthetic sickness except to a very minor degree. Chart 6 shows a very interesting condition in which the opposite of our findings is well demonstrated. The patient was profoundly toxic before the operation with a severe sepsis due to an acute spreading peritonitis originating in the appendix. Our studies thus began at the height of the toxic condition in which the calcium-potassium ratio was inverted and, as the patient returned rapidly to normal, the restoration of the normal mineral salt balance took place.

These changes were first noted by us about two years ago and the preliminary report was issued at that time. Very shortly thereafter appeared
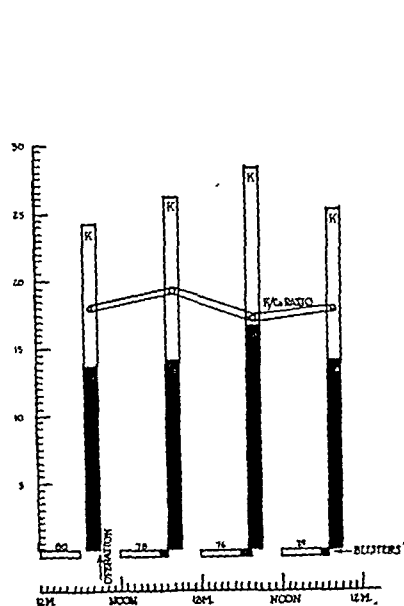
CHART 5.—A partial hysterectomy for small fibroids. Almost total absence of post-anæsthetic sickness. Patient was able to take fluids the same night. The pain minimal. Observations extended until 10:00 the next morning, 24 hours after operation. Only slight change in the calcium.
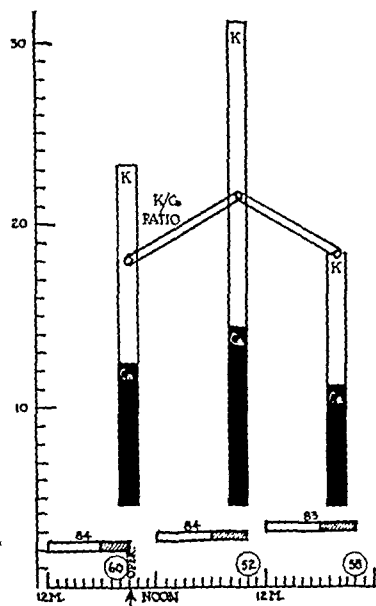
CHART 6.—Right inguinal herniotomy. Operation time 25 minutes, with minimum of trauma necessary. Simple sac excision, suture of the endoabdominal fascia and closure. The anæsthesia was light. Practically no post-anæsthetic sickness. Negligible changes in the mineral salt ratio in spite of sharp rise of calcium, but it was compensated for by equally great rise in potassium. Return to normal in 36 hours.
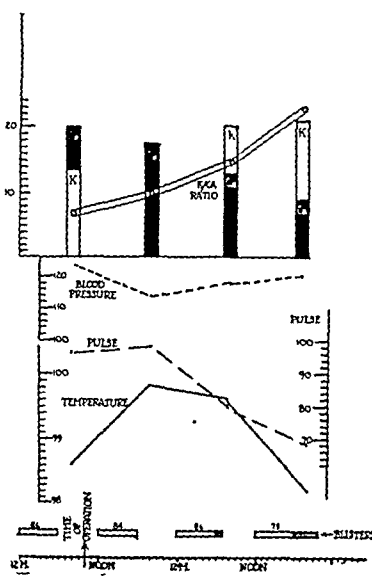
CHART 7.—Case of general peritonitis due to a ruptured appendix of 24 hours duration. Patient exceedingly toxic and drowsy on entrance. Emergency operation with blunt removal of gangrenous appendix, suture of colon over the gangrenous stump and no closure of wound to permit extensive drainage. Observations continued for 37 hours. Note the fact that the marked changes in the K-Ca ratio had begun at the time of the operation and there is prompt return to normal with the recovery of the patient.

the important paper of Emerson[20] on the calcium in the blood in ether anæsthesia and shock. He found a consistent rise in the blood calcium of 18 to 20 per cent. following etherization. Unfortunately, no potassium studies were made. In his experiments the animals were etherized and maintained for one hour in the second stage of anæsthesia, blood calcium being taken immediately before and after. In spite of the fact that the maximal point of the curve was not studied as it was in our work, very marked changes were noted. In his experiments he also added operative procedures in some cases and found that the rise in calcium was no greater, thus in his opinion elimi-

nating the feature of shock as a factor. He noted also a similar marked rise if asphyxia was brought about.

Our findings are by far the most profound changes in the mineral salt balance that have ever been reported, except in a very few isolated cases.
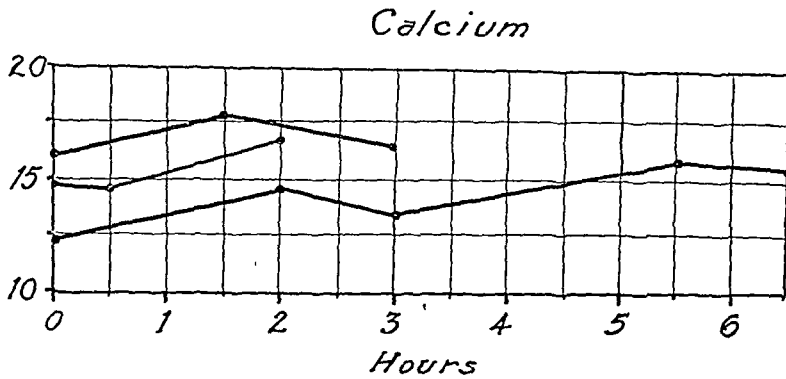
CHART 8.—The blood calcium curves of three dogs; Numbers 1 and 2, cholecystectomies under ether, and Number 3, gastroenterosotomy under ether. Note the rise in the calcium in all cases. Potassium estimations were not made on these sera as the hemolysis was considerable. Unfortunately the studies were not carried out for a long enough time to reach the peak of the curve as shown in Charts 1-4.

Studies of blood calcium and potassium have for the most part been made in chronic experiments in which at the most daily determinations were made. This is true of practically all of the work on deficiency diseases and in the disturbances in parathyroid metabolism. Our findings, however, have been

ALDRICH-MC CLURE INTRADERMAL SALT TESTS

	Pre-operative	6–8 hours Post-operative	20–24 hours Post-operative
1	50	35	78
2	49	45	39
3	68	60	47
4	54	41	59
5	50	37	42
6	53	36	49
7	43	32	47
8	57	39	47
9	53	42	49
10	50	38	61
11	45	41	41
12	61	51	49
13	58	32	37
14	49	29	30
15	50	43	51
16	44	35	39
17	52	33	33
18	53	33	50
19	61	53	41
20	59	40	35

CHART 9.—Absorption time of one-half cubic centimeter of intradermally injected normal salt solution. These observations were made on twenty consecutive cases of ether anæsthesia in the wards of St. Luke's Hospital on patients who were operated on outside of emergencies.

somewhat paralleled in a few instances, notably those of the experiments of Petersen[21] and Mueller on anaphylactic shock; those of Kylin[22] in a few instances and in the studies of Salvesen[23] on permeability. There is a report of several cases of erythema exudatinum multiforme in which the potassium actually fell below the calcium values in the blood. In these studies by Nathan and Stern[24] the authors have put exclamation marks in their tables after these hitherto unknown findings, as if to cast doubt on the acuracy of their own work.

Salvesen[25] has reported certain experiments in which the dog was etherized for an hour and the blood calcium taken immediately before and immediately after the experiment and then again in twenty-four hours. In his table the blood calcium rose .34 milligrams during that hour and had fallen considerably at the end of twenty-four hours. A glance at our tables will show at once that the taking of only two samples following the anæsthesia would naturally completely miss the phenomenon noted by us.

Permeability.—In view of these very striking observations, the studies of the permeability were undertaken according to the method reported by

PERMEABILITY TESTS

	Pre-operative	6–8 hours Post-operative	16 hours Post-operative	20–24 hours Post-operative
1...............	82	84		88
2...............	68	72	76	78
3...............	81	84		88
4...............	80	85	84	83
5...............	73	76		80
6...............	69	75		79

CHART 10.—The ratio of the protein in the blister fluid to the protein in the blood serum of six patients following ether anæsthesia taken at various times before and after operation. Note the constant rise in the permeability index in all the cases. See also Charts 3, 4, 5, 6, and 7.

Gaennslen[26] and afterward elaborated by Petersen.[27, 28] A cantharides blister was applied to the skin and the time taken for blistering noted together with the observation of the protein content of the blister fluid and the patient's serum, according to the method described by the latter authors. I am indebted to Doctor Petersen for his kind assistance in this work.

In a series of six cases studied by us, most profound changes in the permeability were noted. Our findings (see Chart 10), are expressed in terms of the permeability ratio, that is, the protein content of the blister fluid divided by the protein content of the blood serum. In every case there was a marked rise in the permeability as measured by this index and in each case also there was the unusual finding of a lengthening of the time it took the blister to form. These findings of a constantly increasing permeability we believe of profound importance in relation to the very low calcium-potassium figures already reported and point perhaps to a reflection as to the possible source of the calcium found in the blood-stream. Although there is a lengthening of the blister time, denoting the fact that less blood is getting to the

skin, an observation which can be amply confirmed by a glance at the pallor of the skin. The skin proves to be more permeable and one is tempted to assume that there is a passage of calcium from the skin and musculature and bone, that is, the peripheral vascular fields, to the internal organism as a protective mechanism against the changes in the cell membrane brought about by the dissolution of lipoids by the ether.

Discussion.—It is well known since the pioneer work of Loeb that the activity of the individual cell can be profoundly influenced by the mineral salt balance of the surrounding medium. A consideration of the concentration of the various ions themselves is not of such importance as the ratio between these ions. The monovalent ions are generally present to about two or two and a half times the number of bivalent ions. An increase in the bivalent ions (calcium and magnesium) in relation to the monovalent ones (sodium and potassium) causes a lessening of the permeability of the cell. Its membrane, which is probably the condensation layer a single molecule thick of a protein-lipoid complex, behaves very differently in different concentrations of these ions. It was formerly thought that the mineral salts themselves were included in this protein-lipoid complex but recent work showing that certain cells at least are free from calcium ions renders it more probable that the mineral salts are of importance merely in maintaining the proper osmotic relation to the surrounding media. A very large section of the modern literature in biology has to do with such permeability studies. An increase in potassium ions causes an increase in the permeability of the cell. Its metabolism is speeded up and substances make their way through the cell membrane much more rapidly. Dyes, food substances can be seen to pass in and out of the cell with far greater rapidity as the potassium calcium ratio is raised and if it is raised beyond definite limits the cell membrane becomes so permeable that it can no longer restrain the normal contents of the cell and dissolution and death take place. Exactly the opposite takes place if the calcium ion is increased. Then the cell membrane becomes impermeable and substances cannot make their way in and out of the cell. The cell "freezes" and lies dormant, all its interchange with the outer world having ceased, if the calcium ion increase is carried far enough.

It is quite suggestive to realize that unicellular animals could not survive for any length of time in the media the mineral salt balance of which is disturbed to such an extent as we have found in all post-operative cases. Such a cell would lie dormant for a period following which there is coagulation of the cytoplasm and death. Certainly such changes in the media in which the colonies of cells which make up the human organism lie are more than amply sufficient to account for the changes observed in patients post-operatively.

Since the early work of Eppinger,[29, 30] it has become very evident that many of the vegetative functions of the organisms are under the control of the autonomic and sympathetic nervous systems as a balancing unit and that profound changes in many of the metabolic functions are controlled in this

manner. Vagotonia is the term applied to one extreme condition in which most of the inhibitory fibres of the vegetative nervous system are in a hyperactive state and sympatheticotonia to the opposite condition. The studies of Schlee, Mueller, Petersen, Salvesen, Kylin, and other observers together with Eppinger himself have shown the close relation between autonomic and sympathetic nerve balance and the certain blood chemical features. The vagotonic tends to run to hypercalcæmia and the sympatheticotonic stands at the opposite end of the scale. While it would probably be an unwarrantable assumption that the post-anæsthetic sickness is one simply of vagotonia, our findings certainly point to that side of the scale.

According to Hawk and Bergeim,[31] the total amount of calcium circulating in the human system is only about 600 milligrams. In view of the solubility of any of the calcium compounds found in bone and other tissue, the mechanism by which it is kept in place is difficult to understand. One is tempted to assume that with the administration of such a powerful lipoid solvent as ether, the lipoids are brought out of the cell membranes, thus producing profound disturbances in the cell permeability, and that under such conditions there is a call on the calcium so that it is drawn into the blood in overwhelmingly large amounts to compensate for the loss of the lipoids and to keep the interchange between the cell and tissue fluids on a normal basis. As the calcium is probably held in place at least partly by lipoid cell membranes, it is not surprising that such a readjustment would take place almost automatically. This would also explain the marked increase in permeability of the skin of a condition where the calcium in the circulating media is abnormally high, where one would naturally expect the opposite to take place. One might again assume that the solution of the lipoid complex in the cells in the skin is the primary lesion from the ether in the blood and the hypercalcæmia represents a compensatory reaction to maintain as nearly as possible more normal permeability in the capillaries in the internal organism.

Finally, our observations on the water balance in post-operative states suggests that the routine treatment by the injection of physiological salt solution may bring about its improvement more by the giving of monovalent ions than through the water administered. Clinical experience shows beyond the shadow of a doubt that patients feel very much better on administration hypodermatically or intravenously of normal salt solution, and in my own experience the administration of tap water through rectum proved valueless unless the patient was really severely dehydrated. The evidence, therefore, is somewhat suggestive that what our patients need is not water, but salt, and clinical experience tends to bear this out.

SUMMARY AND CONCLUSION

1. Intensive post-operative blood chemical studies were made on patients for twenty-four to thirty-six hours after operation.

2. There were no significant changes in the leucocytes, blood-pressure,

temperature, pulse, blood sugar, water content of the blood, or chlorides or carbon dioxide.

3. Marked changes were found in the Aldrich-McClure test indicative of increased tissue thirst.

4. Tests of permeability of the skin showed that this was much increased.

5. Profound changes in the mineral salt balance were noted. The potassium calcium ratio often fell to below one. These changes *per se* may be considered adequate to account for the condition known as post-anæsthesia sickness.

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TRANSACTIONS AMERICAN SURGICAL ASSOCIATION
MEETING HELD MAY 15, 16 AND 17, 1930; *Continued.*

OBSERVATIONS ON POST-OPERATIVE PULMONARY ATELECTASIS

CONSIDERATION OF SOME FACTORS IN ITS ETIOLOGY, PREVENTION AND TREATMENT

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Our interest in the subject of atelectasis has extended over a considerable number of years. In May, 1928, in a discussion at the American Society of Thoracic Surgery, one of us[17] spoke of the use of CO_2 inhalations at frequent intervals for three or four days following operations. This procedure had been carried on more or less intermittently during the previous year with apparently good results. For some time there has been much discussion and experimental work on the mechanism, etiology, prophylaxis and treatment of post-operative pulmonary atelectasis. In the Clinic on Thoracic Surgery at the University of California Medical School, during the past year, a group has attempted to make careful observations on every patient operated upon. We have carried out these observations in considerable detail and we feel that these findings are worthy of tabulation.

The procedure consisted in the administration of CO_2 inhalations after every operation to produce hyperventilation, whether ether, gas, spinal or local anæsthesia was used. The CO_2 inhalations and changes in posture were repeated three or four times a day thereafter for the purpose of deciding whether or not such a procedure would diminish the incidence of lung complications. On all of these patients careful physical examinations were made of the chest and, so far as was possible, röntgenograms were taken before operation, and many times thereafter, with the first sign of symptoms referable to the chest. When lung complications supervened, CO_2 inhalations and postural changes, depending upon the location of the trouble, were carried out every two or three hours day and night. Certain adjuncts were at times applied, such as steam inhalations, potassium iodide medication, *etc.* Bronchoscopy was carried out in a certain number of patients where it seemed advisable. These observations and results were tabulated. Certain underlying factors were inquired into as closely as possible by laboratory methods. These are still being carried on and have not neared completion.

Composite Röntgen-ray Series. The first essential, obviously, is to know the condition of which we speak. We believe with Churchill[22] and others

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FIG. 1A

FIG. 1B

H.L.NO 3
2ND DAY POST OP
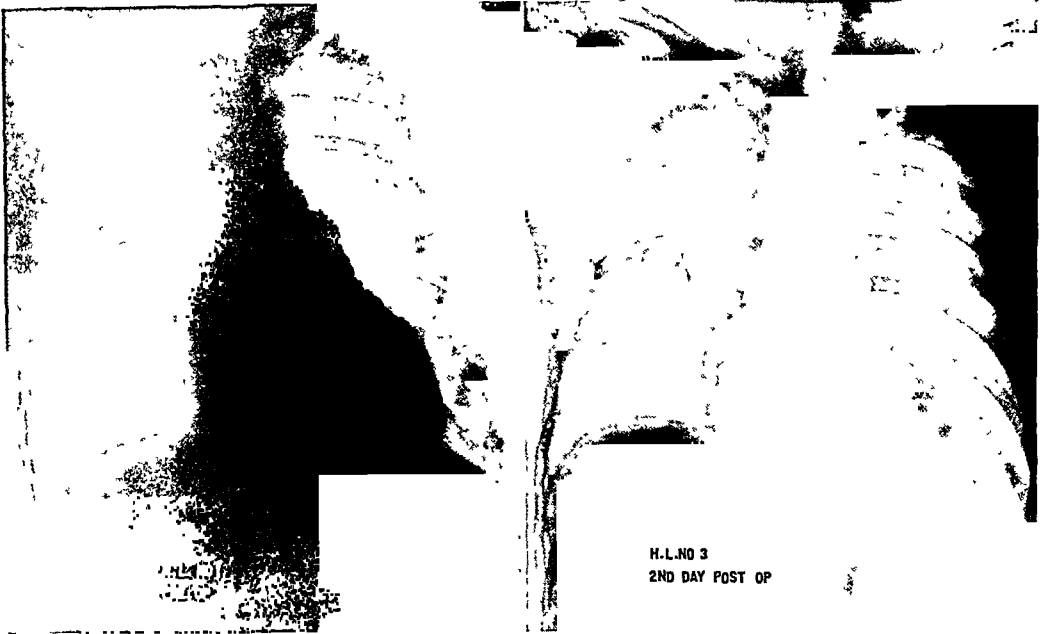
FIG. 1.—Films of H. L., showing a minor degree of atelectasis. Note the increased height of the diaphragm and cardiac displacement in the post-operative film (No. 3), in comparison to the pre-operative film (No. 1). The lung fields are clear.
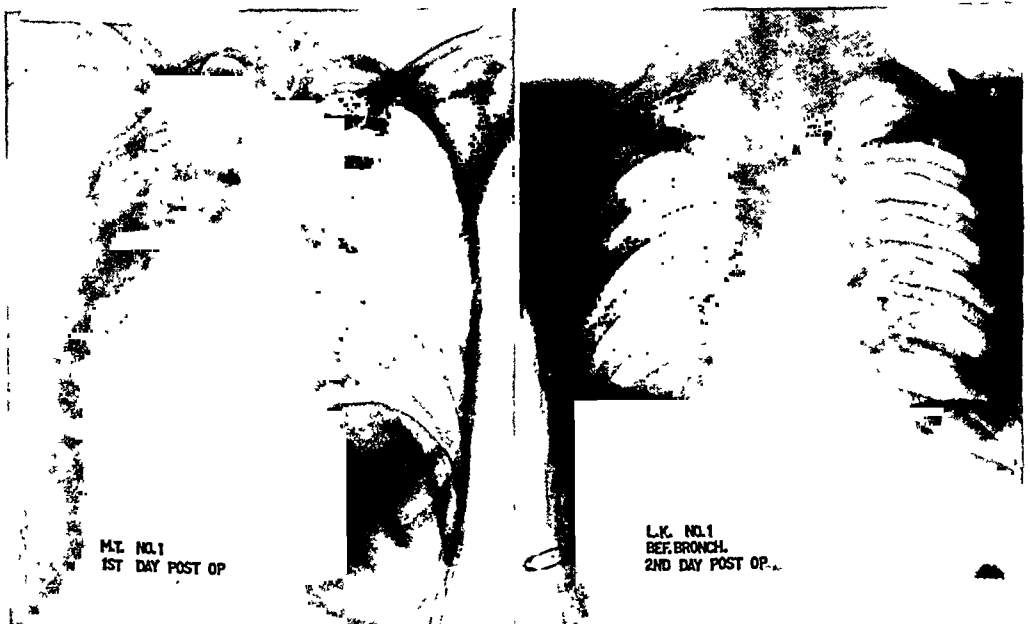
M.T. NO.1
1ST DAY POST OP

L.K. NO.1
BEF. BRONCH.
2ND DAY POST OP.

FIG. 2.—Massive atelectasis of the right lung. Film taken twenty-four hours post-operatively following D. & C. and uterine suspension. Gas-ether anæsthesia. Mucus + +. With CO_2 inhalations and postural drainage, chest cleared in two weeks.

FIG. 3.—Atelectasis of the lateral part of right lower lobe; before bronchoscopy.

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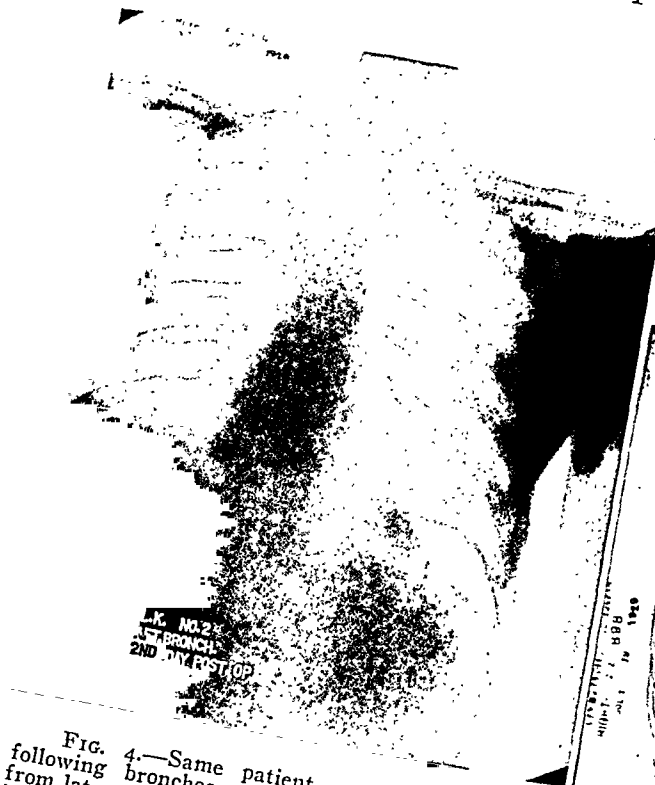
FIG. 4.—Same patient as Fig. 3 shortly following bronchoscopy and removal of plugs from lateral minor bronchi on right. Note clearing of shadow in the right lower lobe.
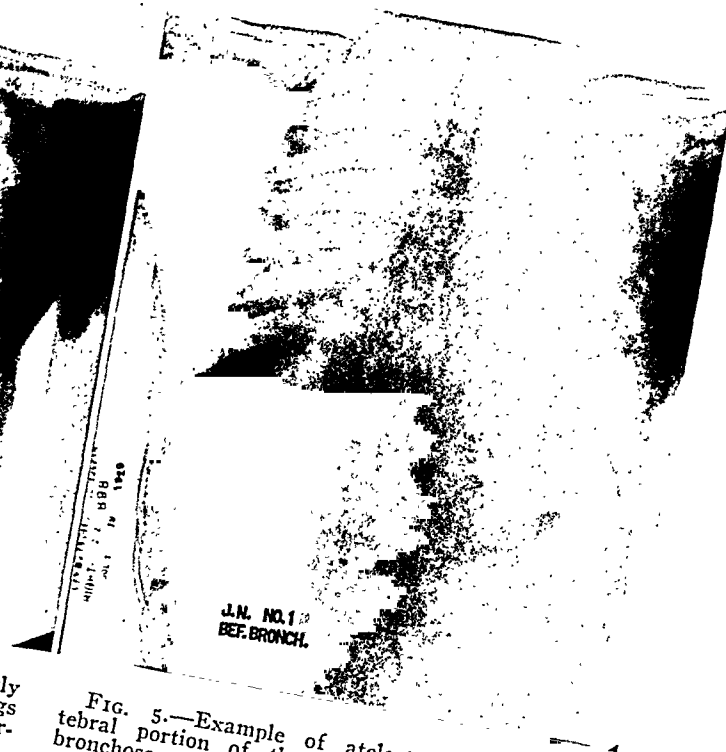
FIG. 5.—Example of atelectasis of the vertebral portion of the right lower lobe; before bronchoscopy.
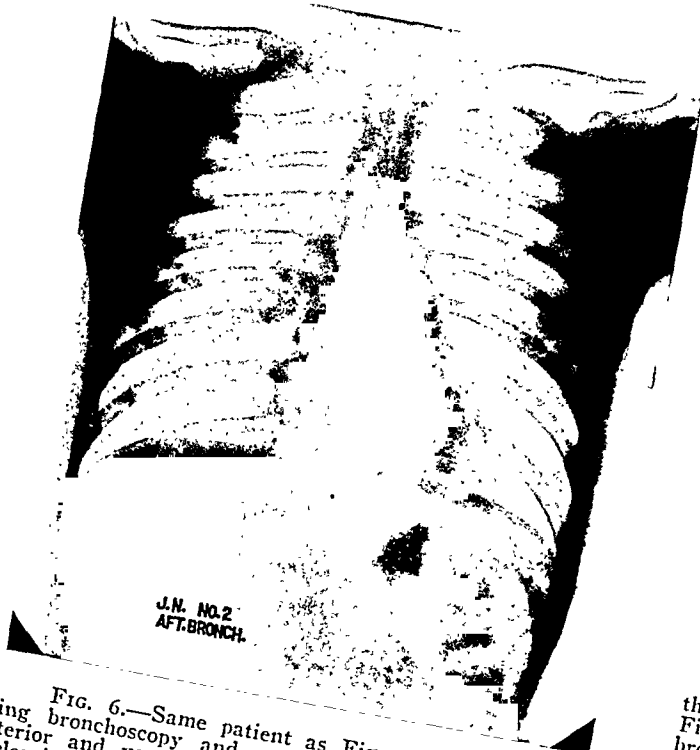
FIG. 6.—Same patient as Fig. 5 shortly following bronchoscopy and removal of plugs from posterior and vertebral minor bronchi on right. Note clearing of the vertebral portion of the right lower lobe.
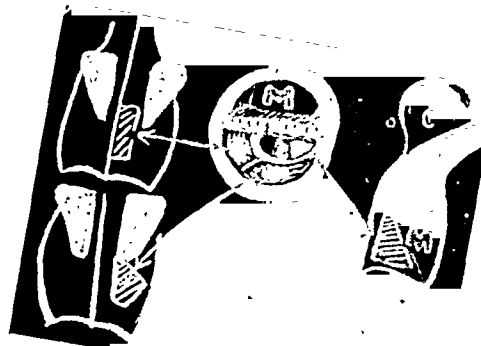
FIG. 7.—Diagrammatic representation of the bronchoscopic findings of Figs. 3-4 and Figs. 5-6. In the centre, the right primary bronchus is depicted bifurcating into the middle and lower lobe bronchi. The location of the atelectatic portion of the lung of L. K. (Fig. 3) is shown on the right with the plugging of a lateral minor bronchus. On the left, the lesion of J. N. (Fig. 5) is shown with the plugging of the posterior and vertebral minor bronchi.

that massive collapse and various other types of atelectases are different stages of the same disease. It is well known that it occurs not infrequently in other conditions. We may have any stage of patchy, lobular, partial or complete atelectasis of part of a lobe, a whole lobe, a whole lung or both lungs. The symptoms and physical findings have been so well and completely covered in previous reports by practically all writers on this subject that there is no need of discussing them further. One must keep in mind that the symptomatology is not necessarily correlated with the extent of involved lung. The chief characteristic of the physical findings is their variability, so that two people examining the same patient within an hour may obtain entirely different findings. The Röntgen-ray is the most helpful adjunct we have in diagnosis and it would seem worth while to present films depicting different stages and types of atelectasis.

The smallest degree of atelectasis to take place post-operatively, as shown by the Röntgen-ray, has been clearly brought out by Muller, Overholt and Pendergrass,[58] and is what they term "pulmonary hypoventilation." Although they state that this condition should be regarded as normal, it might well be considered as a minor degree of atelectasis. They found it to occur "normally" only in upper abdominal operations. However, a similar appearance can be shown by Röntgen-ray following some lower abdominal operations and hernioplasties. Fig. 1 (H. L.) is an example of this very early change following a hernioplasty under gas and oxygen anæsthesia. He had no treatment and Röntgen-ray was essentially normal within four days. At the other extreme, there may be a complete collapse of the whole lung as is shown in Fig. 2 (M. T.). Between these two degrees of atelectasis there may be any extent of lung involvement. Fig. 3 (L. K.) demonstrates a collapse of the lateral part of the lower lobe of the right lung. The proof of this is shown in Fig. 4, the same patient after bronchoscopy and the removal of two small plugs from lateral minor bronchi. Similarly, the vertebral portion of the lower lobe alone may be involved as shown in Fig. 5 (J. N.). Fig. 6 (J. N.) is following the removal of small plugs by bronchoscopy from the posterior and vertebral minor bronchi of the right lung. Fig. 7 is a diagrammatic representation of the bronchoscopic findings in the previous two patients. A complete collapse of the lower lobe may occur, which is entirely opaque to the Röntgen-ray, as is shown in Fig. 8 (P. M.). Fig. 9 (B. V.) again shows a complete collapse of the lung, in this instance on the left side. The patchy, or bronchopneumonic type, is well illustrated in Fig. 10 (F. G.), or what might be called a pneumonic type, is seen in the Röntgen-ray in Fig. 11 (E. M.).

The cardinal signs of collapse, röntgenologically, are elevation of the diaphragm on the involved side, heart, mediastinum and trachea displaced to the affected side, contraction of the ribs on that side, and lung shadow. From the preceding plates, all of which are from proven cases of atelectasis, it can be seen that it is not necessary to have all of these on the film. One or the other of these findings may predominate. We have found the most constant sign to be the elevation of the diaphragm on the affected side. The

type of chest, that is, the mobility and flexibility of the thoracic cage and mediastinum and the location of the lesion, plays a most important part in determining the amount of change shown in the film. Usually, it is massive collapse only that gives all the cardinal signs in the Röntgen-ray plate.

The diagnosis of a pneumonic or a bronchopneumonic process on the Röntgen-ray film of any immediate post-operative chest complication should be looked at askance at the present stage of our knowledge. It is much more likely to be an atelectatic process. One of the films shown above (Fig. 5) was diagnosed pneumonia by five capable röntgenologists in San Francisco. Not until the plate following bronchoscopy (Fig. 6), was shown to them, would they admit that the process was atelectatic. The Röntgen-ray appearance in Fig. 11 could well have been diagnosed as a lobar pneumonia.

Recently Coryllos has doubted the independent identity of post-operative pneumonia. He[25] believes that atelectasis, post-operative pneumonitis, lobar pneumonia (whether lobular, lobar or massive) are produced by the same mechanism. He gives extensive clinical, pathologic and experimental data to support his theory. He thinks that they are all due to "a factor of great importance—*bronchial obstruction*. Any interference with the free drainage of the bronchial tree will cause lesions the nature, extent, importance and evolution of which will depend upon the degree and duration of the obstruction and nature and virulence of the microbes present."

Seventy-five to eighty years ago Gairdner[33, 34, 35] argued long and valiantly in an attempt to prove that atelectasis was an entirely different condition than pneumonia. We have not the wealth of evidence to offer that either Gairdner or Coryllos present but, from careful clinical and bronchoscopic observations, we believe that although the majority of post-operative complications are atelectatic, there are some that are of a different nature. An example of this type of complication is illustrated by the following case.

H. B., female, aged seventeen, was operated upon for acute appendicitis under nitrous oxide and ether anæsthesia. Her pre-operative plate (Fig. 12, No. 1) was entirely negative. Thirty-six hours after operation she developed high fever, elevated pulse rate, and respiratory rate of 40. Her clinical chart is shown (Fig. 13). She had little cough and no sputum. Röntgen-ray examination at this time was still negative (Fig. 14, No. 2). Forty-eight hours after operation the chest film showed a shadow immediately about the left hilus (Fig. 15, No. 3). As is shown in her succeeding chest films (Figs. 16 and 17, Nos. 4 and 5), the process was interpreted as a central pneumonia of the lobar type which gradually cleared (Fig. 18, No. 6). At no time was there any evidence by physical signs or Röntgen-ray that this was other than a pneumonic process. This patient had no sputum and, therefore, no culture could be obta;ned. Bronchoscopy was not performed since there was no indication that it would be of any aid in treatment. The clinical chart was different from the type of chart shown by the post-operative atelectatic patient.

ETIOLOGY

The most fascinating part of this problem is its etiology, which has been heatedly discussed for over a hundred years. Interestingly, this condition was first described in children dying shortly after birth by various German writers, beginning with Schenk,[74] in 1811. They, however, did not

FIG. 8.—Film showing complete atelectasis of the right lower lobe. Diaphragm cannot be seen. Note the heart displacement and dense shadow representing collapsed right lower lobe.

FIG. 9.—Film showing complete collapse of left lung. Note the cardiac shadow entirely hidden in left chest.
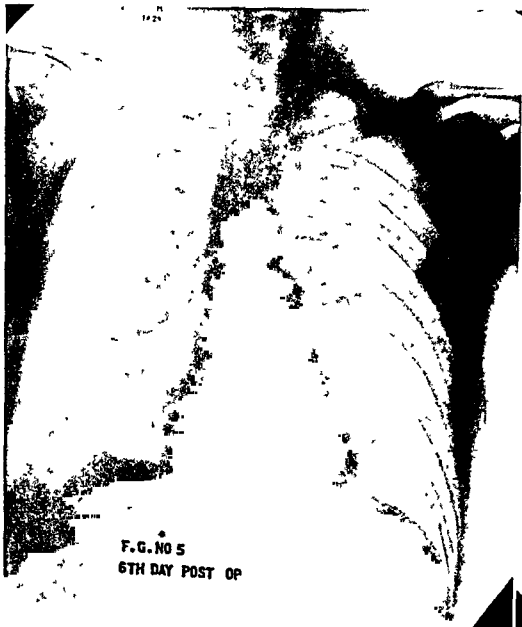
FIG. 10.—Film showing bronchopneumonic type of atelectasis. This film was diagnosed pneumonia before bronchoscopy was performed.
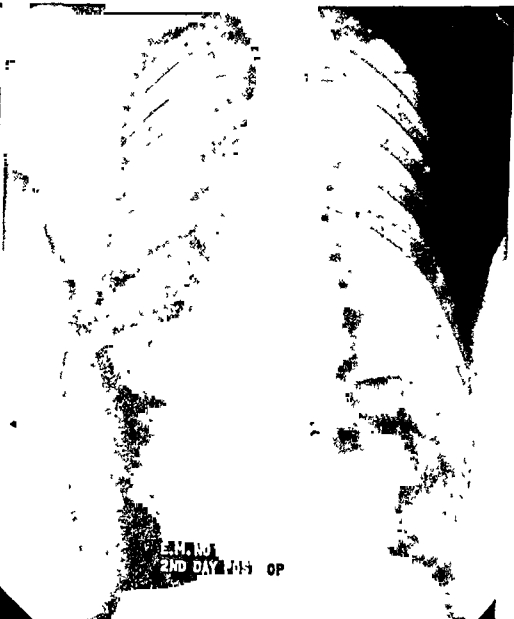
FIG. 11.—Film showing lobar-pneumonic type of atelectasis. Note the height of the diaphragm and cardiac displacement. With vigorous treatment by CO_2 inhalations and postural changes physical signs practically cleared in two hours. The shadow in the right lower chest had disappeared in the film of the following day.

FIG. 12.—Pre-operative film of H. B. Chest negative.
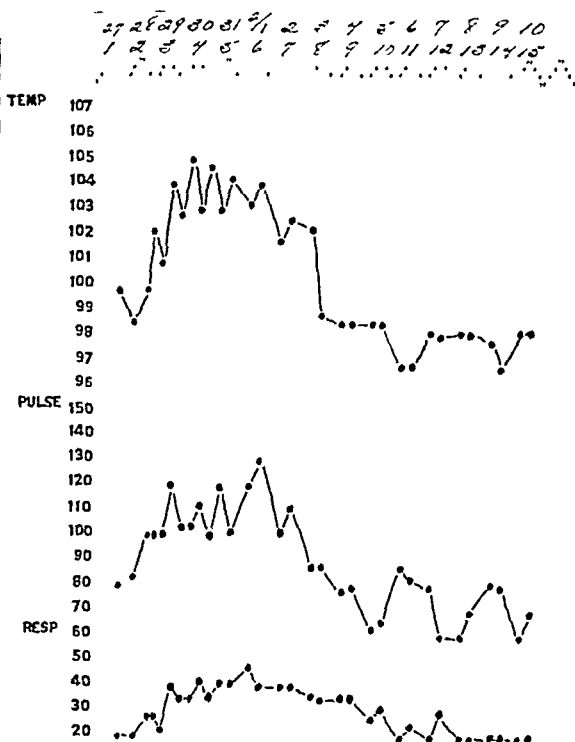
FIG. 13.—Clinical chart of H. B. Note the abrupt rise in temperature and return to normal by crisis; also, the rapid respiratory rate which was sustained throughout her illness. We did not find this typical in our atelectatic cases.

H.B. NO-2
T2I DAY POST OP
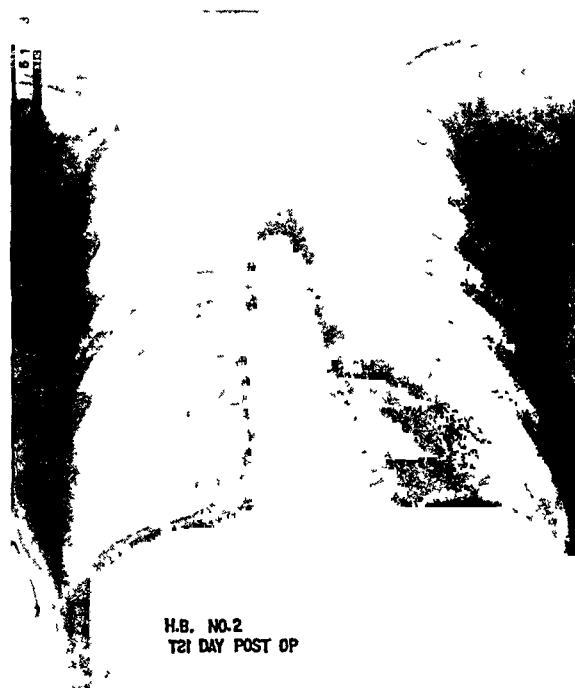
FIG. 14 —Chest still negative. Note that there is not any displacement of the cardiac shadow. The diaphragm is not elevated and ribs are not contracted.

H.B. NO.3
2ND DAY POST OP
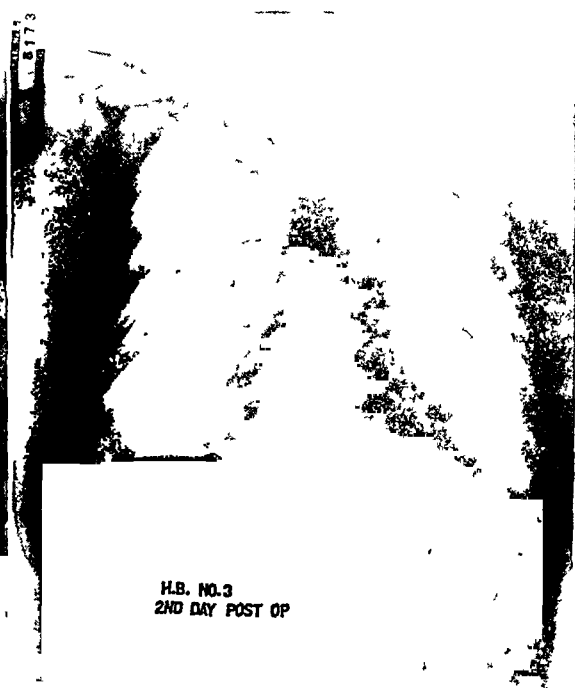
FIG. 15.—Note the shadow about the left hilus, apparently a beginning central pneumonia. There is still no displacement of the cardiac shadow or diaphragm.

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understand it. Louis,[54] in 1829, was the first to describe this lesion in adults and the name atelectasis was given to it by Jörg,[45] in 1835. This author had previously described it in children in 1832. He coined the word *atelectasis* from two Greek words, ατελής, meaning imperfect, and ἔκταβις, meaning expansion. For a complete historical survey of the subject, the report of Bowen[8] should be consulted. Clinically, the medical aspects of this condition were most carefully studied and described by W. T. Gairdner[33, 34, 35] in a series of papers beginning in 1850. Gairdner firmly believed the chief factor in the production of this condition was bronchial obstruction. So bronchial obstruction was the earliest and, as we shall see, is also the most recent of the causes given for the production of atelectasis.

Evidence favoring bronchial obstruction.—There is an overwhelming array of evidence, both experimental and clinical, favoring the theory of bronchial obstruction as a prime factor in the production of pulmonary atelectasis, whether it be post-operative or not.

Mendelssohn,[57] in 1845, showed experimentally that the introduction of foreign bodies —shot, paper ball, thick watery solution of gum arabic—into the air passages, narrowing of the trachea by means of a ligature, opening the pleural cavity or section of both recurrent laryngeal or both vagus nerves, was followed by atelec-

H.B. NO.4
4TH DAY POST OP

Fig. 16.—Film showing diffuse density of left lower chest with no displacement of heart or diaphragm. Ribs are not contracted

tasis. Traube,[83] in 1846, showed that the atelectasis following section of the vagus or recurrent laryngeal nerves was due to the entrance of buccal secretion into the air passages. In 1878–1879, a very illuminating series of experiments were published by Lichtheim,[51] who obstructed the bronchus in rabbits by the introduction of a laminaria plug without opening the thorax. As the plug swelled, the lung beyond collapsed. Collapse did not occur when the blood-vessels to the lung were tied. He also sectioned the phrenic nerve and the spinal cord at the second and third cervical segments. No collapse occurred. He went further and established the speed of absorption of the different gases. Thus, operating on rabbits, he found that after obstruction of the bronchus, pure oxygen is completely absorbed in forty-five minutes and carbon dioxide in from ten to thirty minutes, whereas the nitrogen is absorbed only after twenty-four hours.

During the next fifty years there was little experimental work on this subject. MacCallum,[55] in 1908, had one of his students introduce a pea into the bronchus of a lobe of the lung in dogs. This pea was impacted there in such a manner as to completely obstruct the flow of air to that lobe. At autopsy this lobe was found to be atelectatic and, it is interesting to note, the bronchus behind the obstruction was found to be filled with thick mucus.

Andrus[1] produced a collapse of the left lung in dogs by ligating the left primary bronchus. The lung became completely atelectatic under these condi-

FIG. 17.—Similar appearance to Fig 16. There is some apparent displacement of the cardiac shadow, but at this time the patient was practically well, as shown by the chart, Fig. 13.
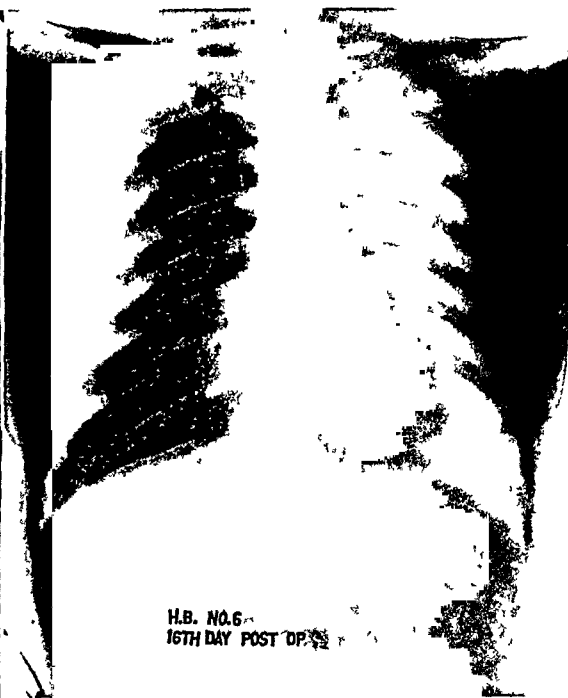
FIG. 18.—Film showing chest returned to normal.

tions within three days after operation. After four months he found a definite and marked fibrosis of the collapsed lung. In the discussion of this report. Archibald states that Scrimger had performed similar experiments with like results.

In 1928, Coryllos and Birnbaum[24] reported the production of atelectasis in the dog by plugging the bronchus with a rubber balloon. By placing the animal in a specially constructed negative pressure box with the chest opened, they were able to watch the development of the atelectasis in the involved lung or lobe. They found that the time necessary for the establishment of atelectasis when the lung was filled with oxygen was about one-half hour, but, when the lung

FIG. 19 —Kymographic record of intra-pleural pressures of both chests of a dog following subcutaneous administration of six milligrams of atropin Horizontal lines are the atmospheric pressures in each chest Above the horizontal lines the pressures are greater than atmos pheric and below are subatmospheric. The down swing of the curve is inspiration and the up swing is expiration. The figures on the graph indicate actual pressure measurements in centimetres of water.

was filled with air, it took about twelve and one-half hours to cause a complete atelectasis, although the process was marked at the end of six hours. Almost simultaneously Lee, Ravdin, Tucker and Pendergrass[48, 49] produced massive atelectasis in the dog by obstructing the bronchus with the tenacious bronchial secretion removed from the bronchial tree of a patient with

FIG. 20.—Introduction of lipiodol into primary bronchus of left lower lobe with the patient in the erect position.

FIG. 21.—Same patient as Fig. 20, turned on the right side, showing lipiodol draining into the right lung.
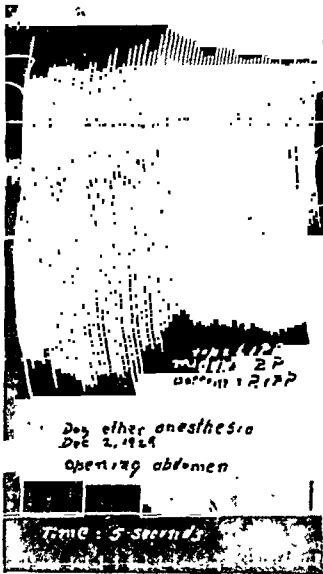
FIG. 22.

FIG. 23.
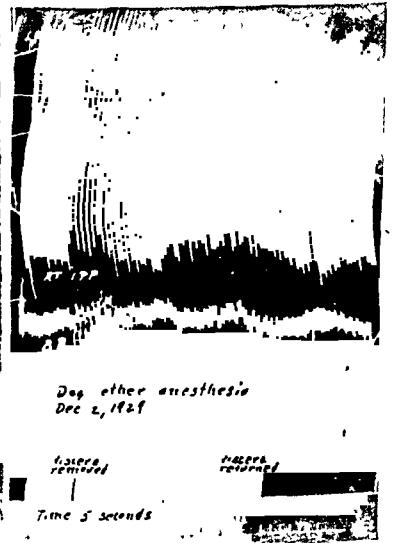
FIG. 24.

FIG. 22.—Kymographic tracing of intra-pleural pressures of both chests and blood-pressure of a dog under ether anæsthesia showing the effect of opening the abdomen. For explanation, see Fig. 19. Note blood pressure curve in centre, superimposed on intra-pleural pressure curves.

FIG. 23.—Kymographic tracing of intra-pleural pressures of both chests and blood-pressure of a dog under ether anæsthesia showing the effect of traction on the stomach. Blood-pressure tracing is superimposed on the intra-pleural pressure curves. For explanation see Fig. 19.

FIG. 24.—Kymographic tracing of intra-pleural pressures of both chests and blood-pressures of a dog under ether anæsthesia showing the effect of removing and replacing abdominal viscera. For explanation see Fig. 19.

massive atelectasis. They emphasized the importance of inhibiting the cough reflex in their animals by the use of sodium amytal.

There have been various explanations as to the fate of the pent-up air in the obstructed lung. The theory that the air of the obstructed lung was absorbed by the blood was first suggested by Fuchs,[32] in 1849, and again by Bartels,[6] in 1861. That this was possible was shown by Lichtheim as mentioned, and, more recently, by Van Allen and Adams.[84] Gairdner,[33] in 1850, suggested that the air was probably expelled by the plug in the bronchus acting the part of a ball valve, allowing the air to escape in expiration, but preventing the access of air in inspiration. Although Jackson[43] and others also believed this to be possible, the theory has been generally given up by most writers on this subject.

Clinical support of the bronchial obstruction hypothesis begins with Gairdner, who discussed in great detail the different types of various secretions that may be found in the bronchi and pointed out that such inspissated mucus could act, and does act, as an obstruction plug. He concludes in his report of 1850: "On reviewing the whole of the facts here presented to the reader, I think that the frequency of collapse of the pulmonary tissue, both in the adult and the child, must be considered as established, and its connection with bronchial obstruction rendered at least extremely probable."

The first to stress the importance of obstructing bronchial secretion in *post-operative atelectasis* were Elliott and Dingley,[29] who studied very carefully eleven cases of post-operative massive collapse. They noted that the viscid muco-purulent expectoration was uniform in all their cases and that this sputum was different in type from pneumonic sputum. More convincing evidence was given by the bronchoscopists[38, 44, 47] from Jackson's clinic who were able to cure clinically the atelectasis by removing the obstructing tenacious secretion, or plug, by the bronchoscope. Cases of recurrences, such as the patient reported by Hearn and Clerf,[38] who was drained seven times, add weight to this hypothesis. A very interesting case has been recently reported by Mathes and Holman[56] in which the patient was able to tell from his symptoms and by a peculiar whistling sound in his chest when the bronchial obstruction was dislodged and so could himself foretell the onset of reinflation of his atelectatic lung. The two cases whose films are shown above (Figs. 3, 4, 5 and 6) also offer rather convincing evidence that the removal of plugs from small minor bronchi almost immediately clears local atelectasis. It has been a common observation that the lung, distal to a bronchus obstructed by a foreign body or tumor, collapses. Reviewing all this evidence, it would seem almost impossible to deny that bronchial obstruction plays a most important rôle in the production of atelectasis. However, there is a surprisingly large amount of data against the bronchial obstruction theory.

Evidence against bronchial obstruction.—Wm. Pasteur, [63, 64, 65] who revived our interest in atelectasis and first emphasized the importance of post-operative atelectasis, never[67] has accepted the bronchial obstruction theory. In his letter[66] to "The Lancet," in 1914, in answer to Elliott and Dingley, he mentions the occurrence of a well-marked case of post-operative collapse without any cough or expectoration. He believed paralysis of the diaphragm and inability of the respiratory muscles to carry on their function properly to be a prime factor in the production of this complication. In this he was undoubtedly influenced by his early observations on atelectasis in post-diphtheritic paralysis.

FIG 25.—Chest film of patient following hernioplasty showing large collections of air under both diaphragms which gave signs in both bases.

FIG. 26.—Film showing effect of abdominal distention on heart, diaphragm and lungs.

FIG. 27.—Same patient as Fig. 26 following soapsuds enema
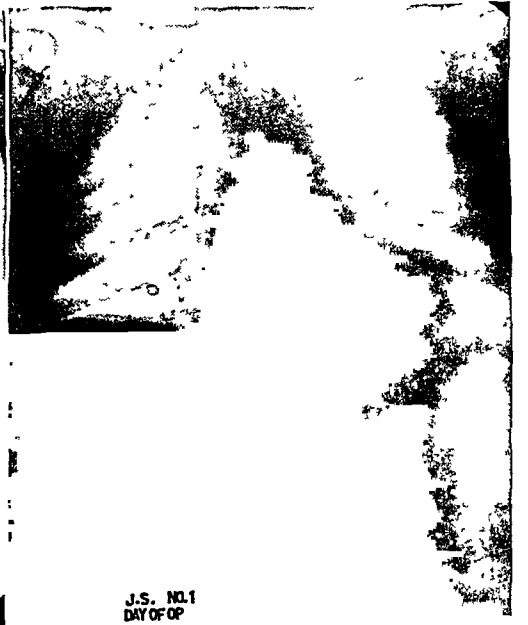
FIG. 28.—Chest film of adult showing effects of abdominal distention.

John Rose Bradford[9, 10] argues rather convincingly against bronchial obstruction as the etiological factor in the war-injury cases he observed. He claimed that there was no evidence of any gross obstruction in the larger bronchi. He stated further that there was definite post-mortem evidence that massive collapse might be present and yet no gross obstruction in the main bronchi found. He described one case of massive collapse of contralateral type, resulting from a non-penetrating wound of the chest wall, in which the soldier had walked four miles after being wounded. Such an instance is difficult to explain by the bronchial obstruction theory.

Briscoe's[14] experiments might be used as an argument that at least partial collapse in localized areas of the lung might take place as a result of injury to the innervation of the respiratory muscles, although his conclusion is that post-operative massive collapse may be produced by diaphragmatic pleurisy. Santee[72] reports

FIG. 29.—Abdominal film of patient shown in Fig. 28. Taken at the same time

two cases of bilateral massive collapse in which there was not any evidence of bronchial obstruction at autopsy. His first case died on the operating

FIG. 30.—This film shows an atelectasis on the right side with fairly marked elevation of the diaphragm and cardiac displacement.
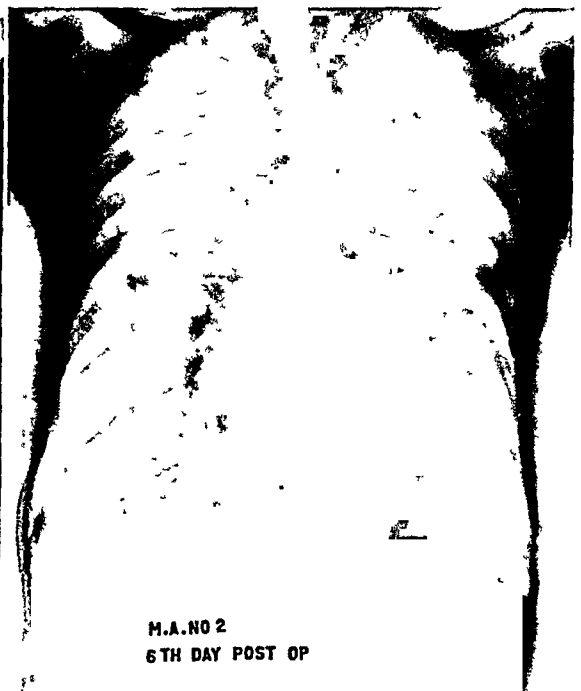
FIG. 31.—Same patient as Fig. 30 following CO_2 inhalations and postural changes.

table. Bergamini and Shepard[7] also report two cases of sudden death during operation in which bilateral massive collapse was found at post-

mortem. They were unable to find even secretion in the bronchi. Such cases offer a powerful argument against the obstruction theory being the only etiological factor in the production of atelectasis and also makes us wonder how the gases in the lungs could have been removed so quickly by the blood-stream.* Experimentally, it has been shown that, following bronchial obstruction, it takes several hours at least for the contained air to be absorbed by the blood. Coryllos' observations have been mentioned. According to Archibald,[2] Scrimger found that after ligating a bronchus of a lobe to produce collapse, it took about twenty-four hours for the air to be absorbed.

Ball[5] reports four cases of pulmonary atelectasis following operation on the thyroid gland. In all of these the recurrent laryngeal nerve had been injured and tracheotomy had been performed. At necropsy obstructing material was carefully searched for, even in the smaller bronchioles, but none was found. The pulmonary vessels were carefully examined for emboli and none found. He believed that the injury to the laryngeal nerves was the important factor in the production of atelectasis in these cases. In another report,[4] he tells of another fatal case of bilateral lobar atelectasis associated with acute pancreatitis. Here, again, no obstruction was found in the bronchial tree. In this case he believed that fixation of the diaphragm was the chief factor.

Lilienthal,[52] while operating on a fibroma in the upper part of the thorax, observed the sudden collapse of the right upper pulmonary lobe. The operation was performed under intra-pharyngeal pressure. The patient died within forty-eight hours and at necropsy the lobe was still collapsed. Lilienthal states: "There was no possible reason to think that there was any obstruction in the bronchus of this patient and there certainly was none at the time of post-mortem section."

The cases reported by Sante[70, 71] may also be used as evidence against the bronchial obstruction hypothesis. However, he did have his patients cough, and plugs, or secretion, may have been dislodged in coughing, although Sante did not believe that this took place.

A most interesting case has been reported by Overholt, Pendergrass and Leopold.[59] This patient had no cough or sputum at any time or any evidence of increased bronchial secretion. Yet she developed a complete massive collapse and cleared with essentially no treatment.

Bradford[9] made an interesting observation that he did not note any case of collapse in head injuries or injuries of the upper extremities. There are practically no cases of atelectasis reported following cranial operations and the neuro-surgeon is not troubled with this complication.† Many of these brain cases are under ether and in one position for hours and, except for the fact that their respiratory muscles are usually unimpeded, these cases have all the factors favoring the production of mucous secretion and, therefore, atelectasis should occur.

Van Allen and Adams[84] reported a very interesting series of experiments. In one animal, kept under quiet respiration, they plugged a bronchus completely for forty-five days and found no atelectasis. They also produced bronchial obstruction with gum acacia, as reported by Lee and Ravdin, and in two dogs with quiet respirations atelectasis did not occur. They were able to produce atelectasis in the experimental animal only when they caused straining respirations.

*Since this paper was written, Coryllos adequately explains the absorption of the intra-pulmonary gases in these cases in Surg., Gynec., and Obst., vol. i, p. 801, 1930.

† Personal communication from Dr. Howard C. Naffziger.

In our laboratory, Brill and Brown[11] have produced mucous plugs in the bronchus of a dog by a method to be described later. When no other complicating factors were present, atelectasis was not produced.

From the above, it can be seen why there are proponents favoring etiological theories, other than bronchial obstruction, for the production of atelectasis. The mere fact that experimentally atelectasis has not been produced by any other method should not be used as too strong an argument against other theories.

Other theories.—There is very little in post-operative atelectasis, as we now know it, to support the theory of Pasteur that it is caused by paralysis of the diaphragm or chest musculature. Churchill[22] reports a case of a woman, aged fifty-two, who sustained a fracture of the cervical spine with almost complete transverse myelitis at the level of the fifth cervical segment. This lesion produced paralysis of all the respiratory muscles, except the diaphragm. She developed a partial collapse of the left lung. He states she was subject to repeated spells of dyspnœa and unproductive cough. This case may then partially support Pasteur's hypothesis. This theory now has practically no supporters, however, although Bradford[9] and Soltau[81] both believe that a reflex paralysis of the muscles of respiration might produce atelectasis.

Besides this reflex action there are two other reflexes which have to be seriously considered. Probably the most important is a reflex by way of the vagus which directly affects the lung and so may cause a collapse. Secondly, there may be a vasomotor reflex which could cause an increased outpouring of secretion in the bronchial tree or some other circulatory change which might conceivably produce atelectasis. Such a mechanism has been suggested by Gwyn[36] and Scott.[75, 77] A strong argument against the nervous origin of atelectasis is that the experimental worker has been unable to produce it by any nervous mechanism. Coryllos[25] points out that no one has given "an exact and precise description of the reflex involved or of the nature of the stimulus itself." However, we should not consider such negative arguments too strongly until it can be shown that another etiological factor, such as bronchial obstruction, can explain all types and cases of atelectasis.

It is well known that surprising phenomena occur as a result of reflex action. Carlson and Luckhardt,[20] working on turtles and frogs, have shown that reflex lung contractions can be induced from stimulation of the sensory nerves of the respiratory tract and mechanical stimulation of the larynx and the nares. They also found that mechanical and electrical stimulation of the alimentary tract, genito-urinary tract, gall-bladder, spleen, central ends of the visceral sympathetic nerves, cutaneous nerves, the cornea and the central end of the sciatic or brachial nerves induce reflex lung contractions which may be very marked. This work is quoted by many as a possibility that the vagus could easily be a path for reflexes causing atelectasis.

The work of Dixon and Brodie[26, 27] is also used in support of the vagal reflex theory. They conclude that the broncho-constrictor fibres run in the vagus only and the contraction of the bronchioles may lead to collapse of over

FIG. 32.—Pre-operative chest film showing nor-
mal chest.
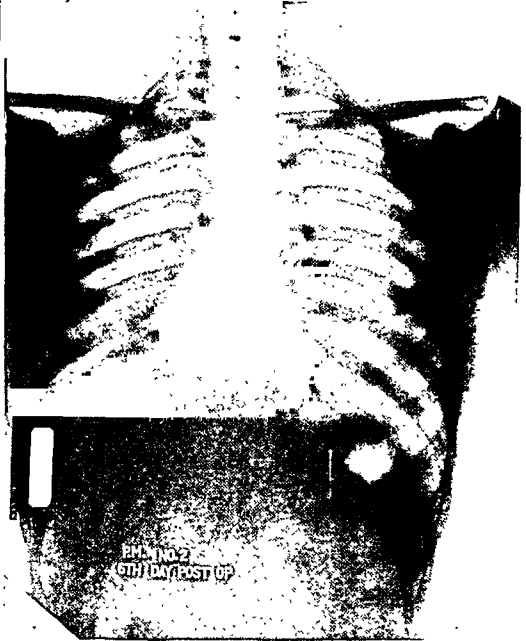
FIG. 33.—Film of same patient as Fig. 32,
six days following hysterectomy and left oopho-
rectomy. Spinal anæsthesia. Was very dyspnœic
and uncomfortable. T. 103°, P. 114, R. 26.
(Same as Fig. 8.)

FIG. 34.—Same patient as Figs. 32 and 33
ten hours following bronchoscopy, which showed
general tracheitis and bronchitis with much pus,
especially in the right lower lobe bronchi. Pus
aspirated.
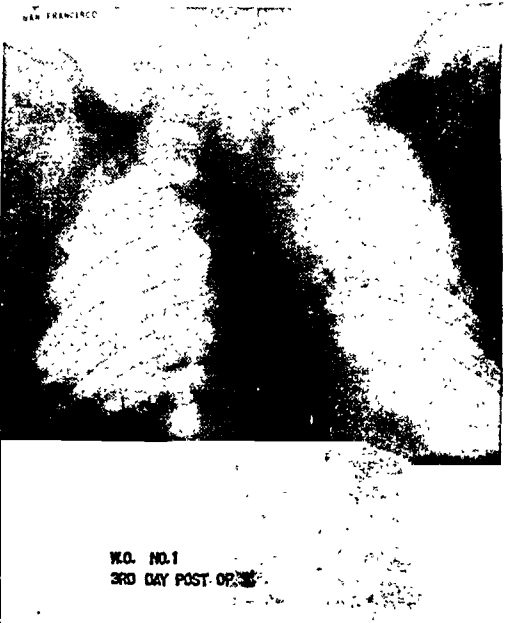
FIG. 35.—Chest film three days following
appendectomy under spinal anæsthesia. Note
shadow, lateral portion of right chest, and com-
pare with Fig. 3 of L. K.
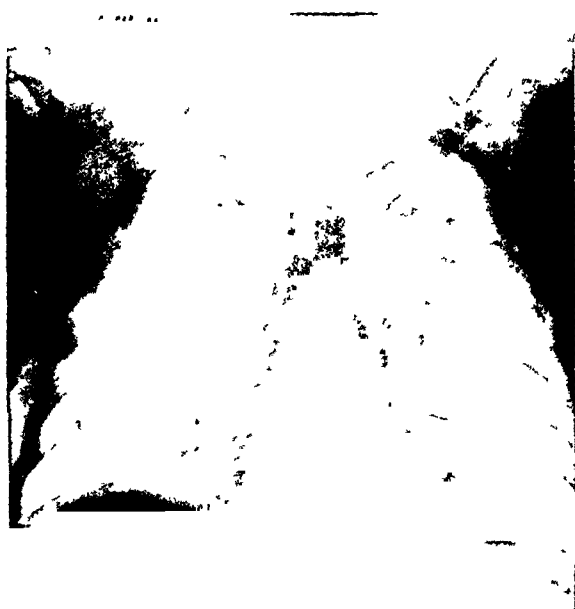
W.O. NO. 3
6TH DAY POST OP

FIG 36.—Same patient as Fig. 35 following removal of viscid sputum which was chiefly in the right lower lobe bronchi.

J.C. NO. 1
3RD DAY POST OP

FIG. 37.—Film of patient following appendectomy under spinal anæsthesia showing practically a massive collapse of the right lung.

J.C. NO. 2
3RD DAY POST OP
AFT. POSTURE & CO₂

FIG. 38.—Same patient as Fig. 37 a few hours later after treatment with CO₂ inhalations and postural changes.
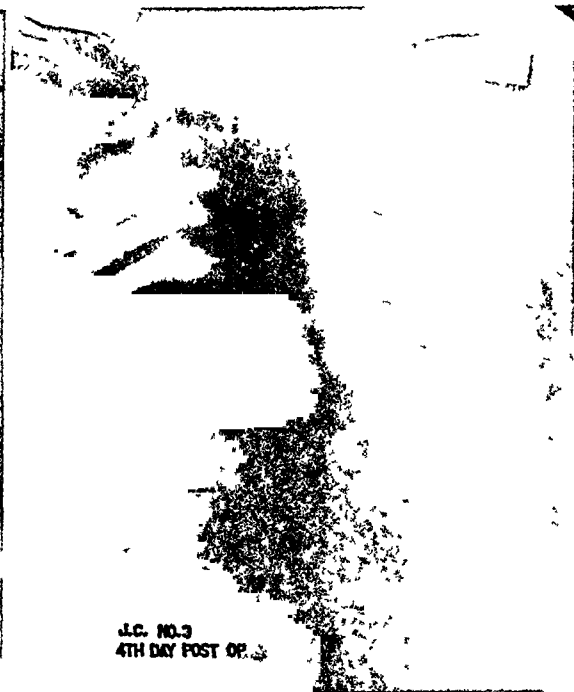
J.C. NO. 3
4TH DAY POST OP

FIG. 39 —Same patient as Figs. 37 and 38 showing recurrence on the following day.

distention of the lung, depending upon the force of the inflation on the one hand, and the time allowed for deflation on the other. In the dog and rabbit, typical bronchiolar constriction immediately follows vagal stimulation.

Fontaine and Herrmann[31] sectioned the extrinsic nerves leading to the left lung in ten dogs. One of these animals suddenly expired on the third day, after having apparently recovered from the operation. At autopsy they found a typical massive atelectasis of the entire left lung and a partial atelectasis of the lower lobe of the right side. They found no obstruction and practically no secretion in any of the larger or minor bronchi. This experiment could be used to throw doubt on both the obstruction and reflex theories since the nerves leading to the left lung had been sectioned. Coryllos,[25] however, believes a pneumothorax occurred in this animal.

Scrimger[79] found that ligature of the small bronchial branches of the vagus with the lung expanded resulted after a delay of a few hours in local areas of collapse, roughly corresponding to the branches ligated. The collapse did not appear at once, and, in his opinion, was due to the absorption of the distal air.

The cases of contralateral collapse which occur shortly after a minor injury are perhaps most easily explained by some type of reflex. At any rate, the reflex theory cannot be entirely discarded at present. There is still a possibility of some type of local œdema, either angioneurotic or due to local irritation, causing an atelectasis of the lung distal to the lesion. That such a localized inflammatory œdema may take place and be the cause of atelectasis has been mentioned by Lord,[53] although he states that it is caused by proximity to an area of bronchopneumonia. One of our group[16] observed a localized area of œdema extending from just above the bifurcation of the trachea down into, and completely involving, the right primary bronchus, practically obliterating its lumen. After epinephrine application it opened up a bit and on the following day the bronchus was practically normal. Bergamini and Shepard thought that their cases were best explained by angioneurotic œdema. Reviewing all the evidence presented as to the etiology of post-operative atelectasis, we must say that at present bronchial obstruction is the most important single factor we know, but cannot say that it is the only factor, or the sole factor.

CONSIDERATION OF CERTAIN FACTORS

Pre-operative.—There are certain factors, pre-operative, operative and post-operative, which, either alone or in combination with bronchial obstruction, aid the production of atelectasis or play a part in initiating the process. Pre-operatively, we should consider first the length of time and the position in which the patient is kept in the hospital. Schaack[73] reports that a group of patients who were kept in the hospital two weeks or more had four times the incidence of post-operative pulmonary complications in comparison with a similar group who were in the hospital only two or three days. He stated further that the incidence of pulmonary complications in both groups was markedly decreased when pulmonary exercises were induced. It is well known that whenever any patient is kept quietly in bed for an extended

period of time, localized areas of atelectasis are very prone to occur. This is especially true in young children, in the aged and the debilitated.

The existence of previous pulmonary disease may play a part in any chest complication. There may be increased bronchial secretions in the bronchial tree favoring plugging. It is well known that in cases of bronchitis there is often a profuse outpouring of secretion during and immediately after the operative procedure. There is always a possibility in a case of bronchiectasis or lung abscess for the pus to cause an atelectasis, whether the patient is operated upon or not. An interesting case of lung abscess with atelectasis has been reported by Elwyn.[30] There is also the possibility of the pulmonary lesion acting as a focus from which organisms may invade a beginning atelectasis, making it more extensive and more serious.

We did not find that the time of year played much part in the incidence of pulmonary complications in our series. Ravdin and Kern,[46] however, found that there was a definite increase in pulmonary complications in the winter and spring which followed the increased incidence of pneumonia on the medical side.

It is well known that lung lesions, cardiovascular disease and acute abdominal lesions—upper abdominal, in particular—may reduce the vital capacity markedly and, as may be readily understood, that reduced vital capacity would favor pulmonary complications and atelectasis. There is a great variation in the vital capacity of the so-called normal patient. A laborer may have a tremendous vital capacity while that of a thin housewife may be quite sub-normal. Whether one or the other of these types is more prone to atelectasis we are not certain, but there is no doubt that if atelectasis occurs, the symptoms of the patient with the sub-normal vital capacity are much more acute.

Pre-operative medication may affect the respiratory rate, the cough reflex, the bronchial secretion and the intra-pleural pressure—all of which may be important factors abetting the production of atelectasis. Brill and Leake[12] have shown that atropin, for example, causes a definite swing of the intra-pleural pressure to the positive side. (Fig. 19.) Writers from the earliest times have noted that atelectasis occurs very commonly in children. It is worth while to consider whether the relatively less negative intra-pleural tension in the young does not favor this condition.

Operative.—At the time of operation the position of the patient on the operating table and the length of time of the operation may favor a collapse. It has been shown that when a patient is flat, or slightly Trendelenburg, his vital capacity is definitely reduced.[21] We also know that if one side of the chest is dependent, secretions tend to collect on that side. Lipiodol observations have permitted us to follow the course of this filling within the lung. (Figs. 20 and 21.) Scott and Joelson[76] report an interesting case of a massive collapse occurring in the dependent lung of a nephrotomy case. Some time later, when the other kidney was operated upon, this same patient developed an atelectasis, this time in the opposite lung which was the dependent one.

FIG. 40.—Same patient as Fig. 39 following bronchoscopy. (See page 829 for case report of J. C.)

J.C. NO.5
8TH DAY POST OP

FIG. 41.—Same patient, J. C. (see page 829 for case report), following second bronchoscopy. The film before bronchoscopy was exactly similar.

J.C. NO.6
12TH DAY POST OP
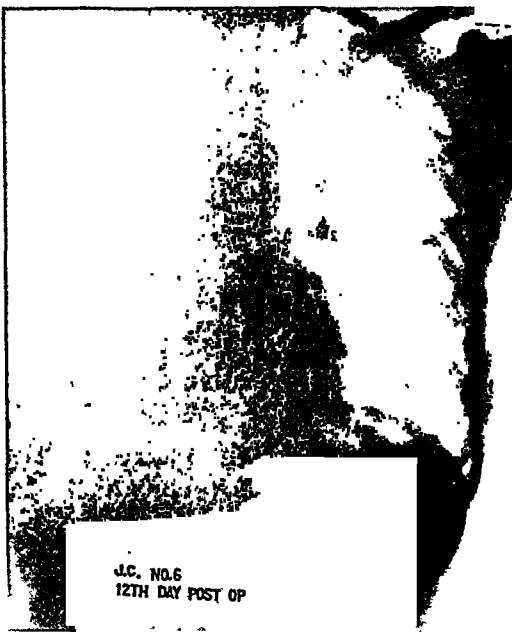
FIG. 42.—Patient, J. C. (see page 829 for case report), showing beginning clearing of right chest.

J.C. NO.7
17TH DAY POST OP
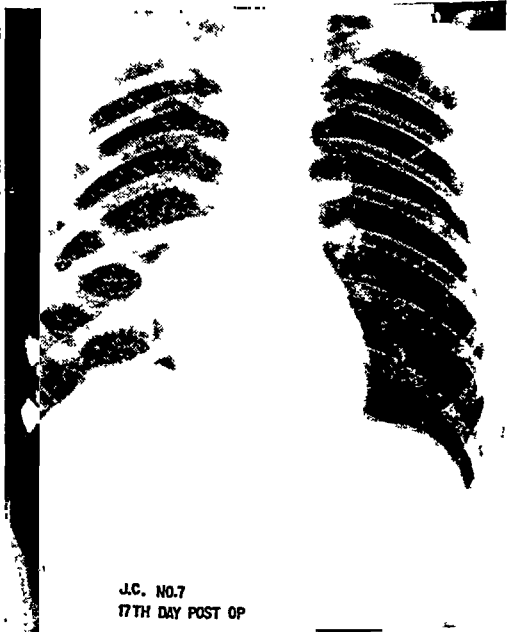
FIG. 43.—Same patient, J. C. (See page 829 for case report.) Chest practically normal.

There is no definite evidence that the length of time that the patient is on the operating table has any marked effect on the production of atelectasis.
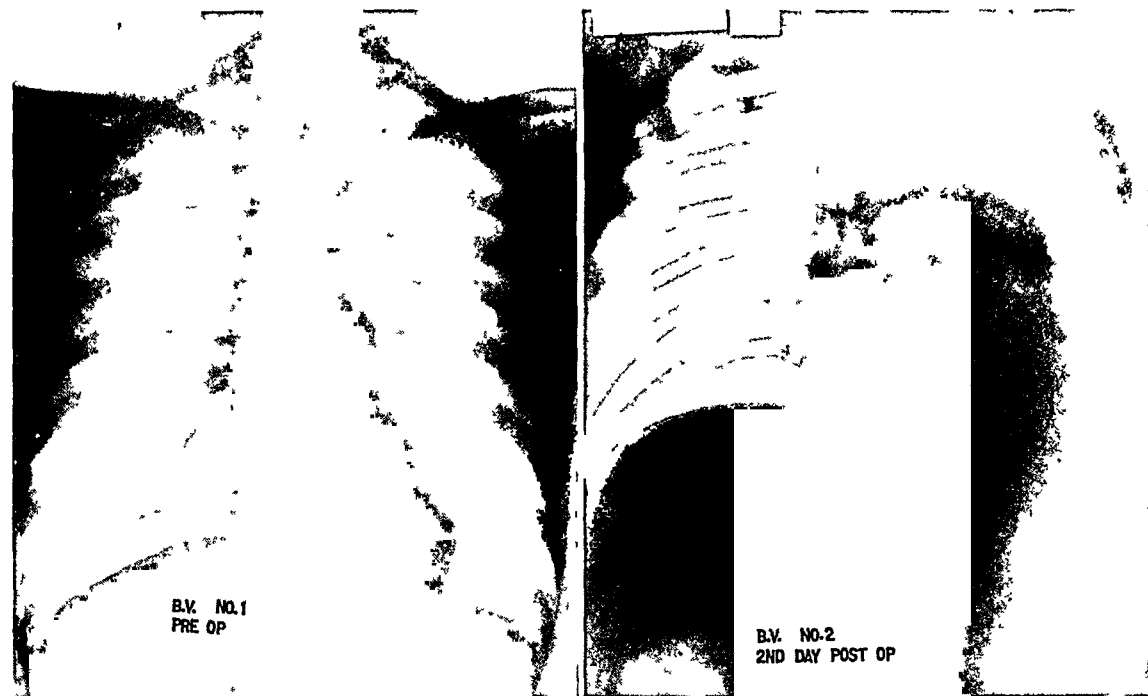
FIG 44 —Pie operative film of B V. (See page 830 for case report) Essentially normal.

FIG 45—Film, second day, following gastric resection showing an almost massive atelectasis of the left lung—B V. (See page 830 for case report.)

In our cases of gastric resection atelectasis occurred with great frequency. Whether or not this was due to the length of time of the operation or to other factors we are unable to state. In general, it has been claimed that upper abdominal operations have a greater incidence of atelectasis, but our figures do not bear this out, with the exception of gastric resection as noted.

It is difficult at this time to judge whether the anæsthetic plays any important part since most authors agree that the complication is as frequent under all anæsthetics. In

FIG 46 —Chest film of B. V. (see page 830 for case report) three days post-operatively showing clearing of the left lung following CO_2 inhalations and postural changes

the series we have been reporting, spinal anæsthesia was used in 62 per cent. of the cases. So far as we can judge, the incidence was not diminished.

The surgical procedure itself may have a marked effect on the physiolog-

ical process going on in the chest. The effect on the respiratory rate, for example, when traction is put on the mesentery has been noted by all surgeons. Little attention, however, has been paid to the changes which take place in intra-pleural pressure which may play quite a part in favoring chest complications. Pressure on the abdomen, evisceration and traction of various organs and the mesentery have a marked effect on the respiratory rate and intra-pleural pressure as shown by Brill and Leake.[13] (Figs. 22, 23 and 24.) A fuller report on this work is to be made later.

Post-operative.—That the post-operative position of the patient may be a factor in the production of atelectasis is generally agreed, as is also the necessity for frequent postural changes. The possibilities are, to keep the patient flat in bed; head dependent and feet elevated; or in the Fowler position. There are two important effects to consider. The *first* is the effect of the patient's position on his freedom of respiratory movements and vital capacity. It has been amply demonstrated that with the head dependent, the vital capacity is greatly reduced and respiratory movements are impeded. The same is true to a lesser degree when the patient is flat in bed. With the patient in the Fowler position there is probably the least impediment for free respiration and the vital capacity is increased. These points, therefore, favor keeping the patient in the Fowler position post-operatively whenever possible and, of course, changing the position frequently as mentioned. The *second* is the effect of the patient's position on intra-bronchial secretions. A careful study has been made on intra-bronchial drainage by the use of lipiodol in the human being. Faulkner[18, 19] has demonstrated that pulmonary secretions may easily pass from one lung to another or may gravitate within one lung to different lobes. Postural drainage has long been used in the treatment of lung abscess, but we do not feel that it has been employed in keeping with the principles of internal drainage. By careful study of the anatomy of the bronchial tree we have worked out the different positions which should drain various lobes of the lung into the trachea immediately after operation.

The relation of posture and spilling is shown in upper lobe atelectasis and suppuration. With the patient lying upon his back, all the physical findings are limited to the upper lobe, whereas the lower lobe is clear. As soon as the patient assumes the erect position and deep breathing exercises are instituted, the abnormal signs in the upper lobe may clear and appear in the lower lobe. We have interpreted this as a mechanical spilling from higher to dependent areas. This spilling is dependent on the patency of the bronchus, posture of the patient, the relative position of the bronchial openings and the viscosity of the intra-bronchial secretions.

Churchill and McNeil,[23] Powers[68] and others have shown the marked diminution in vital capacity following certain operative procedures. Muller, Overholt and Pendergrass[58] have beautifully demonstrated effects on chest expansion, elevation of the diaphragm and limitation of the diaphragmatic movements in these cases. In our clinic we have confirmed most of these findings and have been somewhat interested to note the time interval it takes

for this diminished vital capacity to return to normal. In many cases it is found to be three months post-operatively. All these factors favor any pulmonary complication, as well as atelectasis in particular.

In the post-operative treatment of the patient the effect of drugs on the respiratory mechanism may be again mentioned. Their possible action has been discussed. Other procedures, such as any that would impede respiratory movements, vital capacity, or the ease of expelling bronchial secretions must all be considered as favoring a pulmonary complication.

The part played by entrance of air into the peritoneal cavity and its collection under the diaphragm is not well understood. That such collections may be quite large in amount is shown in Fig. 25, No. 1. Whether the air

FIG 47 —Film of B V (see page 830 for case report) seventh day post operatively showing recurrence and complete atelectasis of left lung. (Same as Fig. 9)

FIG. 48.—Chest film of B. V. (see page 830 for case report) following further treatment with CO_2 inhalations and postural changes. Note marked clearing in comparison with Fig. 47.

has an irritant or somewhat paralyzing effect, we cannot say at present. The diaphragm, however, is elevated. Acute dilatation of the stomach and bowel distention may also have a marked effect on the respiratory mechanism. Fig. 26, No. 1, is a Röntgen-ray of a little girl following an appendicitis operation who had signs of dulness, rales and diminished breathing at both bases. A diagnosis of atelectasis was considered. Note the height of the diaphragm and the rotation of the heart. Following an enema the chest picture entirely cleared, and physical signs were essentially normal. (Fig. 27, No. 2.) Another example of this phenomenon in an adult may be seen in Figs. 28 and 29, Nos. 1 and 2, which show the same effect on the diaphragm and the heart. Note the marked bowel distention. This patient's chest signs also cleared following colonic flush.

The changes produced in the intra-abdominal tension by these complications and their effect on intra-pleural tension is not clear. However, these pressure changes may also affect pulmonary physiology.

Bronchoscopic observations.[*]—The use of the bronchoscope in the diagnosis and treatment of atelectasis has greatly extended our knowledge of this disease. Its value in diagnosis and treatment cannot be overestimated. Leopold [50] first suggested its use in this disease and the first reports by Jackson and Lee[43] of the cure of atelectasis by aspirating the plug were dramatic.

Our bronchoscopic observations[16] in cases of proven atelectasis, broadly considered, can be grouped into three main types of cases: first, there are those in whom the bronchus is found obstructed, either with a plug or the characteristic tenacious sputum, to be described; secondly, there is another group in whom there is no complete obstruction, but a rather profuse, purulent secretion, not so viscid as the typical tenacious type; and, thirdly, we may find practically no secretion at all. In this latter type, there is always the possibility that during the process of preparing for bronchoscopy the plug has been expelled. The unusual finding of a practically complete occlusion of the right main bronchus by an œdematous swelling of the mucous membranes has been mentioned.

The characteristic sputum in these cases is a thick, pearly, yellow, gelatinous and tenacious material which, when placed in a container, adheres firmly to it even when inverted. Such material, we believe, produced the more extensive types of atelectasis. The sputum may also be thinner in consistency and purulent, which is probably the type that may produce scattered, or patchy, atelectasis. Other cases have practically no sputum. Further observations will be mentioned under prevention and treatment.

Prevention.—The pre-operative, operative and post-operative factors which may favor the occurrence of atelectasis have been discussed. The use of CO_2 induced hyperventilation, and postural changes as a prophylactic measure deserve special mention. The administration of CO_2 immediately following the operation for the purpose of de-anæsthetizing the patient was first suggested by Henderson, Haggard and Coburn,[39] in 1920.[‡] They claimed that besides the above action various physiological processes, especially the vasomotor apparatus, were rapidly restored to normal by this procedure. Although Reimann, Bloom and Reimann[69] disagreed with them, the weight of evidence seems to favor Henderson's contention. Little attention, however, was paid to this work up to the past three years. In 1927, Sise, Mason and Bogan[80] suggested the use of CO_2 inhalations and various postural changes as a prophylactic measure to lessen the incidence of post-operative pneumonia. This report was published in June, 1928. At the same time a report by Scott and Cutler[77] appeared on the use of an exactly similar procedure as a prophylactic measure against massive atelectasis and one of us[17] had independently suggested it. Scott[77, 78] reports a reduction in the incidence of

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[*] Bronchoscopic observations were made by William B. Faulkner, Jr., and by A. L. Brown.

[‡] In a personal communication from Yandell Henderson attention is drawn to the fact that the therapeutic use of CO_2 inhalations was suggested by him in 1905. Henderson, Y.: Acapnia as a factor in shock. Brit. Med. J., Vol. ii, p. 1812, 1906.

massive atelectasis from 0.6 per cent. to 0.25 per cent. by the use of such prophylactic measures. More recently, Henderson, Coryllos[41] and their associates report excellent results with the use of CO_2-induced hyperpnœa, not only in prophylaxis, but also in the treatment of post-operative atelectasis and pneumonia in general.

We have administered CO_2 on the operating table after all inhalation anæsthesia. Following other types of anæsthesia, such as local and spinal, the procedure was not constantly carried out. All operative cases during the past year have been given CO_2 inhalations without oxygen, three to four times a day for the first three or four days following operation. It is useless to compare this series with that of previous years since chest complications had never been so carefully looked for and, by comparison, therefore, we apparently have an increased incidence of this sequela. In this connection, it is interesting to mention again the recent report of Van Allen and Adams, who found, in the experimental animal, that straining respirations favored the production of atelectasis when the bronchus was plugged, while with quiet breathing they were unable to produce the lesion. Henderson,[40] on the other hand, says: "Shallow breathing strongly predisposes to bronchial obstruction and thus to atelectasis in the obstructed areas. Contrariwise, deep breathing tends to distend the lungs and to reopen areas of atelectasis. The natural stimulant to deep breathing is the carbon dioxide produced within the body."

Bronchoscopically, we have noted that the administration of CO_2 produced: (1) increase in the rate and depth of respiration; (2) production of violent movements in the tracheo-bronchial tree and alterations in the shape of the lumenæ of its branches, thereby tending to free adherent mucus; (3) induction of a distinct blanching of the mucous membranes of the trachea and bronchi.

If CO_2 is administered with the patient in the proper position, the resultant widening of the bronchus permits the secretions to spill from minor bronchi to major ones. This frequently produces a coughing paroxysm, even when the major bronchus has been thoroughly cocainized. With this paroxysm the patient tends to expel the secretions.

We believe that CO_2 inhalations may affect the patient in one of two ways. He may either be markedly improved or made decidedly worse. The difference in the outcome depends on the posture assumed by the patient during the administration of the CO_2 inhalations. If the patient is placed in such a position that the involved area is uppermost and the bronchial opening leading from it is dependent, the CO_2 inhalations lead to a satisfactory drainage and expectoration of secretion, whereas, similar inhalations, with the involved area dependent and the bronchial opening uppermost, will interfere with adequate drainage and expectoration and permit the secretions to run deeper into the lung.

Archibald and Brown[3, 15] have noted experimentally that cough and violent respiratory effort may tend to drive fluid substances, similar to

J.C. NO.1
PRE OP

FIG. 49.—Chest film of B. V. (See page 830 for case report.) Return of chest to normal.
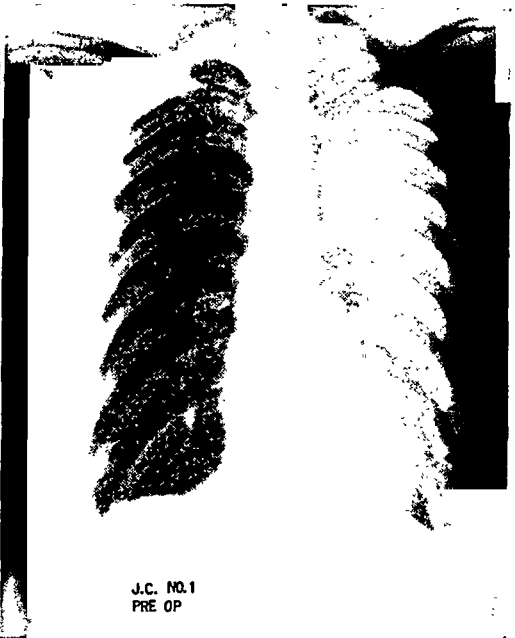
FIG. 50.—Pre-operative film of J. C. (See page 831 for case report.)

J.C. NO.2
1ST DAY POST OP

J.C. NO.3
4TH DAY POST OP
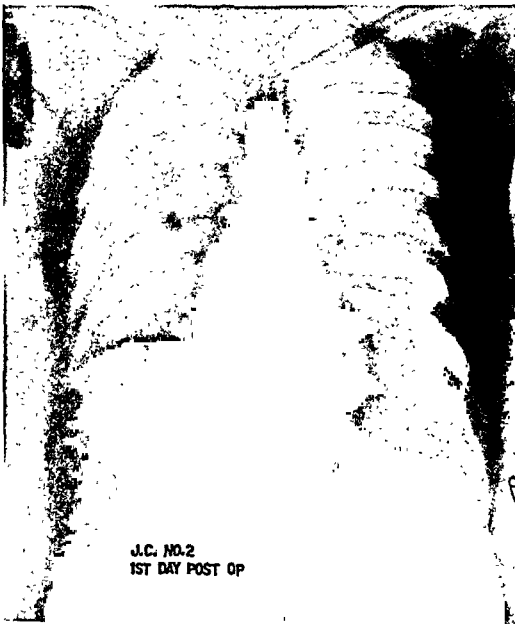
FIG. 51.—Film of same patient as Fig. 50. (See page 831 for case report.) First day post-operatively showing atelectasis in the right lung with peculiar triangular shadow leading from the right hilus.
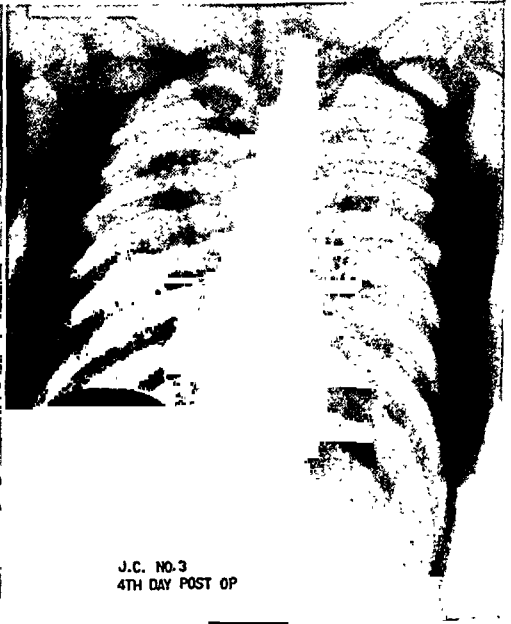
FIG. 52.—Film of same patient as Fig. 51 showing some clearing of triangular shadow but no decrease in cardiac displacement or height of diaphragm.
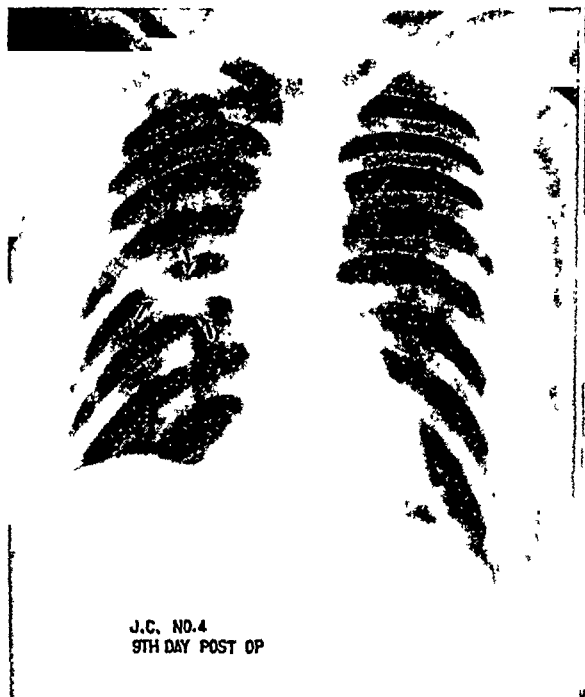
J.C. NO.4
9TH DAY POST OP

FIG. 53.—Same patient, J. C. (see page 831 for case report), showing return of diaphragm and heart toward normal relations, but change in the triangular shadow which is to become a lung abscess.

J.C. NO.5
14TH DAY POST OP

FIG. 54.—J. C. (see page 831 for case report) showing definite Rontgen-ray evidence of lung abscess with heart and diaphragm returning to normal position.

J.C. NO.7
29TH DAY POST OP

FIG. 55.—Same patient, J. C., four days before death, showing the extent of the lung abscess. The intervening plates are omitted.

J.C. NO.8
29TH DAY POST

FIG. 56.—Same as Fig. 55. Lateral view. Note location of the abscess in the upper part of the lower lobe and fluid level.

iodized oil, deeper into the pulmonary tree. This does not take place with a heavier substance, such as thick, tenacious sputum. This action of cough, if it can be applied to the human, is of great importance. A successful outcome with CO_2 inhalations and postural changes is, therefore, dependent on: (1) knowledge of the anatomy of the tracheo-bronchial tree; (2) the relative position of the various bronchial openings; and (3) the course of the bronchial stems.

The post-operative posture of the patient has been sufficiently discussed. It is only necessary to add that in certain cases where there is profuse bronchial secretion during and immediately after the operative procedure, we have found it advantageous to place the patient in the Tredelenburg position for from one-half hour to an hour and allow the secretions to drain out. It is worth while to consider here whether it would not be of value to employ bronchoscopic aspiration immediately after operation in cases where there has been profuse bronchial secretions. In two cases where the lungs were flooded with secretion and blood this procedure was carried out (by William B. Faulkner, Jr.), and these patients developed no post-operative lung complications.

Treatment.—The treatment of this condition is in the experimental stage. According to some authors,[28, 37] in cases of massive collapse, symptomatic relief may be obtained by the introduction of air into the pleural cavity on the affected side. As Bowen[8] states: "Pneumothorax is mentioned here, only to condemn it." While it is true that this procedure may allow the displaced mediastinum to return to its normal position due to the relief of the increased intra-pleural tension, it does nothing to relieve the pulmonary pathology as we understand it.

As carefully as the older writers studied atelectasis, the displacement of the heart and mediastinum was not recognized by them. Although Bowen gives Stokes[82] credit for having noted mediastinal displacement, a careful perusal of his treatise makes us believe the condition which he calls "the vesicular emphysema of Laennec" is not atelectasis. Samuel West,[85] in 1908, first remarked on the marked displacement of the heart in a case of collapse of the lung in a girl suffering from plastic bronchitis. Pasteur, in his later papers, recognized the importance of the heart displacement, but at first was somewhat confused as to its mechanism. Elliott and Dingley proved the cardiac displacement to the affected side by röntgenograms and adequately explained it by concluding that the intra-pleural tension must be greatly increased on the involved side. The measurements of Elkin[28] and others[37] since that time show their deductions to have been correct.

Sante's report has been mentioned previously. Scott, Cutler, Bowen and others comment favorably on his suggestion of rolling the patient back and forth on the uninvolved side. We have had a good deal of success using this procedure, at times somewhat more elaborated with the principles of intra-bronchial drainage, mentioned above, and in combination with CO_2

inhalations. An excellent example of the results that may be obtained with this type of treatment is shown in the following case.

M. A., male, aged forty-nine, had a right-sided hernioplasty under spinal. His temperature, pulse and respirations had been normal on the fifth day post-operatively, when he suddenly developed a fever of 102.8°. The respiratory rate was 28, and he began to raise thick, tenacious, green, purulent sputum. Fig. 30, No. 1, is the chest film taken on that day. He was given CO_2 inhalations every two hours and various postural maneuvers were applied. On the following day his chest film (Fig. 31, No. 2), was essentially normal.

Not all cases, however, respond so promptly to this type of treatment. Certain ones, in spite of vigorous treatment with CO_2 and postural changes, clear very slowly, while others (in a control series from another hospital) may recover in less than a week with no treatment. However, in general, there is no doubt that this type of treatment shortens the convalescent period and may prevent complications.

The results of bronchoscopic aspiration in atelectasis, as has been stated, may be very marked. The series of films of P. M. (Figs. 32, 33 and 34, Nos. 1, 2, and 3), and the series of W. O. (Figs. 35 and 36, Nos. 1 and 3), demonstrate what a marked change may take place within a few hours in a case of collapse of the entire right lower lobe or part of it. Figs. 3, 4, 5 and 6, given above, are also examples of marked clearing following this procedure.

There are certain types of cases that will recur under any form of treatment. This is especially true if they are uncoöperative, as was the following patient.

J. C., male, aged twenty-seven, two days following an appendectomy under spinal anæsthesia for acute appendicitis developed a cough, some fever, increased pulse rate and a respiratory rate of 35. He brought up large amounts of thick, purulent, tenacious sputum. Physical examination showed dulness, absent or diminished breath sounds and moist crepitant rales at the right lower chest. Heart and trachea were displaced to the right. The film taken on the next day (Fig. 37, No. 1) confirmed these findings. He was immediately put on CO_2 inhalations and postural changes. Röntgen-ray film, taken a short time afterward (Fig. 38, No. 2), showed some clearing just above the diaphragm and beginning return of the displaced heart and mediastinum. However, on the following day (Fig. 39, No. 3), his findings were as bad as, or worse than, at the onset. In the next two days he showed no improvement, so it was decided that bronchoscopy was indicated.

The bronchoscopic report is as follows: "There is a general tracheal bronchitis, marked with placques of pus in the trachea; two large gelatinous plugs to the left side of the carina, each the size of a bean. Similar types of pus, but of smaller bulk, were encountered in both upper lobe bronchi and at scattered areas throughout the other bronchial openings. The minor tertiary divisions of the posterior and vertebral bronchi contained pus of a similar nature."

Immediately after bronchoscopy there seemed to be some improvement. (Fig. 40, No. 4.) The patient, however, continued to do poorly. On the eighth day, post-operatively, it was decided to bronchoscope him again. The report is as follows: "Entire tracheo-bronchial tree of an extraordinary fiery red color, equally as red as on the original examination. The right posterior minor bronchus has a very definite, thick,

gumous, gelatinous plug occluding its opening. This plug was not dislodged on coughing which was associated with cocainization or the passing of the bronchoscope. We removed the plug mechanically. The vertebral tertiary minor bronchus was not plugged. Even though no pus was encountered in the middle lobe on first examination, at this time, following the application of CO_2 and adrenalin, several good-sized chunks of pus were forced out on coughing."

The Röntgen-ray film, before and after bronchoscopy, showed no change in the condition (Fig. 41, No. 5), and the question arose as to whether or not a pneumonia had been ingrafted in this case. From this time on the patient cleared very slowly. (Figs. 42 and 43, Nos. 6 and 7.)

This case seems to be one of atelectasis (as shown by the height of the diaphragm on the right and the cardiac displacement) on which a pneumonia was ingrafted and, perhaps due to the uncoöperative type of patient, was not helped by any type of treatment.

A similar case, but one that did not have bronchoscopic treatment, is shown in the next series of plates.

B. V., male, aged forty-seven, had an extensive resection of a large callous ulcer on the posterior wall of the stomach under spinal, gas and ether anæsthesia. His pre-operative chest film (Fig. 44, No. 1) was essentially normal. On the second day, post-operatively, he developed a cough and brought up small quantities of thick, yellow phlegm. His temperature, pulse and respirations were only slightly elevated. His film on that day (Fig. 45, No. 2) showed an atelectasis on the left side with marked displacement of the heart and mediastinum. He was put on our routine treatment of CO_2 inhalations and postural changes and on the following day was markedly improved (Fig. 46, No. 3). On the seventh day, post-operatively, his sypmtoms recurred and the film taken on that day (Fig. 47, No. 4), showed practically a massive collapse of the left lung. A consultation was held to decide whether bronchoscopy should be done at this time but, on account of his good condition and lack of dyspnœa, it was decided to continue the use of CO_2 inhalations and postural changes. He brought up a large amount of thick sputum under this régime and felt markedly improved. The plate on the next day (Fig. 48, No. 5), showed marked clearing and from this time the lungs gradually returned to normal (Fig. 49, No. 6).

To summarize our present opinion as to treatment, we believe that the CO_2-induced hyperventilation, combined with frequent postural changes, according to the principles of intra-bronchial drainage, should be used as soon as the complication is recognized. A large number will clear up rapidly under this régime. If they do not and if the symptoms are at all acute, or if from the character of the sputum and the physical findings there is evidence that there is a plug, or tenacious sputum, we believe bronchoscopy is indicated. We have never had a bad result from bronchoscopy and believe that this procedure in the hands of a well-trained man is without danger or ill effects.

Prognosis.—All observers have noted that many of these patients get well without treatment. The scarcity of autopsy reports in this complication is due to this low mortality. We have not had a death in an uncomplicated case of atelectasis.

The case of J. C., noted above, demonstrated that a pneumonic process may be ingrafted on an atelectatic process. An instance of lung abscess complicating an atelectasis is described in the following report:

J. C., female, aged thirty-seven, had a curettage and laparotomy for sterilization under spinal and ether anæsthesia. The pre-operative plate (Fig. 50, No. 1), was essentially negative, although she was supposed to have had tuberculosis at the right apex. Fig. 51 (No. 2), first day post-operatively, taken not because of respiratory symptoms but in our routine study, showed an irregular triangular shadow radiating from the right hilus toward the apex with irregular mottling throughout the right base. There was marked elevation of the right diaphragm with the heart drawn to the right and ribs contracted. The triangular shadow was diagnosed as an infarct but, in view of subsequent events and the marked displacement of the diaphragm and heart, we believe this to be an atelectasis of the apex of the right lower lobe. At this time she had no sputum. T. 38°, P. 110, R. 32. She was treated for atelectasis with CO_2 inhalations and postural changes, but was very uncoöperative. On the fourth post-operative day (Fig. 52, No. 3), the triangular shadow was decreased in extent and she seemed to be improved. After this time the patient became worse and bronchoscopy was suggested and refused. She continued having an irregular fever and elevated pulse and cough with little sputum. The plate taken on the ninth post-operative day (Fig. 53, No. 4), showed the heart and diaphragm returned to normal position, but a new process had started. The arrows point to a beginning abscess forming in the upper portion of the right lower lobe. At this time T. was 38.8°, P. 80, R. 24.

By the fourteenth post-operative day, the process was much more marked and the abscess cavity seemed to have extended. At this time the patient was beginning to have foul abscess sputum. Temperature rose to 39° every afternoon. She refused any type of treatment. Figs. 54 and 55, Nos. 5 and 7, show progress of the abscess. The lateral view (Fig. 56, No. 8), taken shortly before death, gives a better idea of the location and extent of this abscess.

On the thirty-third day post-operatively, the patient suddenly developed a coughing paroxysm, became very dyspnœic with many coarse, gurgling rales throughout both chests. Before anything could be done for her, she expired. Death, apparently, was due to the abscess breaking and flooding the bronchial tree.

Repeated examinations of her sputum throughout her illness always showed streptococcus viridans predominating and a few colonies of staphylococcus aureus and staphylococcus albus. There were no elastic fibres, tuberculosis bacilli or spirochetes. Guinea pig was inoculated and was negative for tuberculosis. It is interesting that ten months previous to operation she had had her sputum cultured three times. Each time streptococcus viridans and a non-hemolytic streptococcus was found. A vaccine was made of this with which she was treated for asthmatic attacks. Unfortunately, at post-mortem the abscess was not cultured, but the report on the stained abscess wall is as follows: "Bacteriological examination of tissue from abscess wall shows a few scattered Grampositive cocal formations, apparently diplococci."

The post-mortem report (Dr. G. Y. Rusk) is as follows:

"Anatomical diagnosis.—Abscess of upper portion of lower lobe of right lung, *apparently of bronchogenic origin.* Irregular pneumonic consolidation with beginning organization and interstitial pneumonia in adjacent regions. Purulent bronchitis in lower lobe of left lung. Purulent tracheitis." (Remainder of this portion of report is not significant.)

Gross examination.—The left lung is essentially negative except for some compensatory emphysema and pus and cloudy œdema on the bronchi. The right lung shows chronic pleural thickening and interlobular adhesions. The upper lobe is negative. "On section of the lower lobe the upper half presents an irregular network of septa dividing the tissue between a number of pus-containing cavities of varying size. The tissue forming the walls of the cavities presents varying degrees of consolidation and some œdema; some areas are opaque, yellowish gray, as if containing fat, others

hyperemic and beefy-looking, apparently beginning organization. Dissection of the bronchi in this neighborhood again shows a hyperemic, velvety surface with purulent exudate. The septa between the pus cavities in part appear relatively firm as if they represented to some extent bronchiectatic cavities. The pneumonic consolidation adjacent to the abscesses forms an irregular layer about two centimetres thick along the upper border of the lower lobe and consists of irregularly disseminated areas of consolidation throughout most of the lateral and posterior portion of the lower lobe.

"*Microscopic examination. Lungs.*—Sections from wall of abscesses show a lining for the most part consisting of a fibrinous exudate containing a few polymorphonuclear leucocytes and mononuclear cells. At a few points bits of bronchial epithelium are encountered and rarely some of this is converted into a flat squamous type of cell. Beneath the fibrino-purulent exudate the tissues show a variety of pictures. Many of the alveoli contain contracted masses of fibrin about which there are mononuclear cells of varying types, some large cells of epithelial type from large fat-containing cells and an occasional lymphocyte. Some of the fibrin tangles are penetrated by vessels and young connective tissue cells. The alveolar walls are œdematous, thickened, showing varying amount of infiltration with lymphocytes and plasma cells and undifferentiated mononuclear cells together with a varying amount of overgrowth of young fibrous tissue elements. This organizing and interstitial pneumonic process extends widely in the tissue. *It appears that the process is of bronchogenic origin rather than an embolic process originating in the parenchyma of the lung with secondary openings into the bronchi.*"

This we believe to be a case of lung abscess ingrafted on an atelectasis. The autopsy strongly supports this, as do the Röntgen-ray studies. Whether the complication was due to the fact that this atelectatic area was never properly drained and became secondarily infected with a virulent organism, or whether there might have been a secondary infarct in the atelectatic area which made a fertile field for a virulent organism, we cannot say. Churchill[22] has suggested that multiple emboli might complicate an atelectatic area and favor a pneumonic process being ingrafted on it. Also Holman and Mathes[42] have been able to produce pulmonary abscess with sterile emboli in the presence of previous infection, either pulmonary or systemic.

In general, the prognosis of the uncomplicated case of atelectasis is excellent. The majority recover, treated or not. When complicated by a virulent pneumococcus infection or other organism which may produce lung abscess, gangrene, *etc.*, the prognosis may be serious. Bilateral massive atelectasis of any extent, unless immediately relieved, will, of course, cause death. Reports of such cases have been mentioned.

SUMMARY AND CONCLUSIONS

1. The predominating post-operative pulmonary complication is atelectasis. This may be of any extent, from involvement of very small portions of pulmonary parenchyma to a whole lung or both lungs.

2. Bronchial obstruction is the most important single factor in the production of atelectasis, and with the relief of the obstruction the lung tissue reinflates. Pre-operative, operative, and post-operative factors which may aid the formation of this lesion have been discussed. Whether these factors,

Statistics on Post-Operative Complications in Major Operations

Anæsthetic	No. of Operations	Per Cent of Operations	Type of Complication					
			Atelectatic	Per Cent	Pneumonic	Per Cent	Embolic	Per Cent
Spinal............	232	} 62	{ 12—5.1%	} 5.7	6	2.6	2	0.9
Spinal and Gas or G. and E.......	49		{ 4—8.2%					
Gas–O............	107	23	2	1.9	1	0.9	0	
Ether............	42	9.2	3	7.1	2	4.8	0	
Local............	18	4	1	5.6	0		0	
Miscellaneous (Amytal, avertin and unknown)........	8	1.8	0		0		0	
Totals..........	456	100.0	22	4.8	9	2.0	2	0.4

Total pulmonary complications = 7.2 per cent
Of all pulmonary complications atelectasis = 67.0 per cent

These complications do not include patients who post-operatively had signs of scattered atelectasis or congestive areas in the lungs of an evanescent nature, but which did not show on the Röntgen-ray plate. Two of the cases classified under pneumonia were hypostatic congestion and might be regarded as atelectatic in nature due to accumulated secretions. In the whole series there were six deaths; three in the pneumonia group and three from the atelectatic group. Of the latter, one was an old lady of eighty whose atelectasis had cleared but who died a month post-operatively very suddenly; the second was a man who developed hemiplegia and the third was a case of lung abscess described in the text.

either alone or through a reflex, may initiate the process and secondarily produce obstructing secretion, we are unable to state.

3. Bronchoscopically, we noted four types of findings in atelectasis: (1) the presence of an obstructing plug or characteristic tenacious sputum; (2) a profuse, purulent secretion; (3) no secretion in the bronchi; (4) one unusual case of local bronchial œdema.

4. In prophylaxis and treatment, the importance of applying the principles of intra-bronchial drainage in the posture of the patient, in combination with CO_2 inhalations, was discussed. The use of bronchoscopic aspiration in prophylaxis, as well as in treatment, was suggested.

5. The prognosis of this post-operative lesion, unless complicated by a secondary process, is excellent.

6. We do not believe that all post-operative pulmonary complications, excluding embolic types, are of the same nature. From clinical, Röntgen-ray and bronchoscopic observations, there seems to be one type that is more like lobar pneumonia. An example of this type is given.

and experimental work on which this paper is based, and to Professor C. L. Leake, in whose pharmacological laboratory some of the experimental work was performed.

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THE TREATMENT OF FRACTURES BY OPEN OPERATION AND DIRECT FIXATION

A CRITICAL SURVEY OF AN EXPERIENCE OF TWENTY YEARS, AND MORE PARTICULARLY OF TWO CONSECUTIVE FIVE-YEAR PERIODS

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THE year 1880, which saw the foundation of the American Surgical Association, saw also the publication by Sir William Macewen, my illustrious predecessor, of his book on "Osteotomy."[1] Even prior to that year Macewen had been interesting himself a great deal in the surgery of bone, a subject which I have often thought was nearer to his heart than many of his other scientific interests. At almost every stage in his professional career, and whatever other lines of work might more particularly engage his attention for the time being. problems connected with the development and repair of bone constantly intrigued him.

I need not here refer in any detail to the history of the transplantation of bone, nor to the classical case of heteroplastic transplantation of bone described by Macewen—the case operated on in 1878 by him originally, and the progress of which was followed up by him for over thirty years. Nor need I do more than refer to the great periosteum controversy in which Macewen delighted to take part—save to remind you that there are few today who would dispute the essential justice of Macewen's contention, namely, that the function of the periosteum was not osteogenic, but limiting, protecting and vascular.

Macewen's monograph on "Osteotomy" was based on an extensive series of observations and operations which he had been carrying out for a number of years upon the varying osseous deformities of rickets, and upon the surgical treatment of these. He had already made several contributions to the literature of the subject, and he had communicated his views and results to the profession, in the course of various discussions in medical societies, and by several communications in medical journals of the day. His monograph dealt also, in a comprehensive way, with the etiology and pathology of rachitic osseous deformities of the lower limbs. It remains a classic.

The method of osteotomy which Macewen described—particularly supracondyloid osteotomy of the femur for the treatment of genu valgum—soon established itself not only as sound and safe. but as the operation of choice in the treatment of genu valgum. I have described elsewhere[2] the great personal triumph achieved by Macewen at the discussion in the section of surgery at the "Congrès Internationale des Sciences Médicales" held in Copenhagen in 1884, when other surgeons such as Ogsten. Chiene, and

Bryant, with one accord admitted the superiority of Macewen's method and technic.

I make this allusion to Macewen's monograph on "Osteotomy" because the mass of clinical material, the results of which he was able to present, implied an adventure into a new surgical realm which, but for the discoveries of Lister, would have been hazardous in the extreme, if not indeed entirely impossible. It was rendered possible by, and only by, the practical application of the principles of antiseptic surgery. When one remembers that the 835 osteotomies carried out on 557 limbs of 330 patients were performed almost without suppurative mishap—in only eight cases did wound infection occur, and in only one did it lead to serious trouble—and that practically all were dealt with in the very earliest days of the Listerian régime, one cannot fail to realize that the record was remarkable.

It occurred to me that it might not be inappropriate on this occasion, when you have been good enough to invite me to join with you in the celebration of the fiftieth anniversary of the foundation of your Association, were I to choose as the subject of a short paper, another branch of the surgery of bone in which, even as in this particular field dealt with by Macewen, the principles and practice of antiseptic, or aseptic, surgery, are of paramount importance. I refer to the treatment of fractures by open operation.

During the last thirty years, and more particularly during the last twenty years, the operative treatment of fractures and the use of internal or direct methods of fixation, to the inception of which we owe so much to the enthusiastic advocacy of Sir Arbuthnot Lane, have been widely practiced and very widely discussed. The literature of surgery has been full of communications on the subject, and in the earlier years particularly, there was waged a controversy marked by very wide divergence of opinion. Nowadays, I fancy, there is less disagreement as to the justification, at least in appropriate cases, for the operative treatment of fractures, though there still exists a certain number of stalwarts who would very narrowly limit its field of usefulness.

I am one of those to whom the passing of the years has brought, so far, no diminution of enthusiasm for the method, and to whom indeed there seems to present itself, as time goes on, an ever-widening field for its application.

My earliest contribution on the subject was at the discussion in the surgical section of the British Medical Association in London, in 1910.[3] As a comparative junior I had become convinced, even then, that open operation was justified, and indeed, greatly to be preferred in many cases of fracture of the long bones, to the older, more orthodox methods up to then in vogue. In my contribution in 1910, I boldly stated the grounds of my confidence, and I endeavored to lay down certain broad principles which should guide one to the adoption of open operation in cases of fracture. These broad principles, in my opinion, still hold good, but I would construe them now in a much more liberal and comprehensive way.

When the British Medical Association met in Glasgow in 1922, I pre-

TABLE II

Second Series of Five Years

Cases of fracture of all kinds treated in Professor Young's wards in the Western Infirmary, · Glasgow, in each of the five years, May, 1922, to May, 1927, showing the number of cases submitted to open operation, and the number treated by direct fixation—with relative percentages

Year	Total fractures	Submitted to open operation	Treated by direct fixation	Percentage of total fractures treated by direct fixation	Percentage of cases of open operation treated by direct fixation
1922–23.....	119	61	38	32	62.3
1923–24.....	95	44	18	18.94	40.9
1924–25.....	135	56	22	14.81	39.3
1925–26.....	137	49	24	17.51	49
1926–27.....	146	57	24	. 16.44	42.1

general survey of which will show that, allowing for the casual variations in numbers of cases treated, and the inevitable differences in severity and extent of the fractures in different years, there has been arrived at a considerable degree of stabilization in respect of the numbers and percentages of cases submitted to open operation and to direct fixation.

TABLE III

Combined Ten Years' Series

Cases of fracture of all kinds treated in Professor Young's wards in the Western Infirmary, Glasgow, in each of the ten years, May, 1917, to May, 1927, showing the number of cases submitted to open operation, and the number treated by direct fixation—with relative percentages

Year	Total fractures	Submitted to open operation	Treated by direct fixation	Percentage of total fractures treated by direct fixation	Percentage of cases of open operation treated by direct fixation
1917–18.....	127	42	9	7.086	21.4
1918–19.....	135	49	11	8.14	22.4
1919–20.....	161	62	28	17.39	45.16
1920–21.....	152	58	19	12.50	32.76
1921–22.....	118	61	36	30.50	59.0
1922–23.....	119	61	38	32	62.3
1923–24.....	95	44	18	18.94	40.9
1924–25.....	135	56	22	14.81	39.3
1925–26.....	137	49	24	17.51	49
1926–27.....	146	57	24	16.44	42.1

It may be of interest also to give here the figures and percentages for the combined ten years' total number of cases. They are as follows: the total number of cases for the ten years amounted to 1,325. In the treatment of these a general anæsthetic was employed 864 times. The total number of administrations of a general anæsthetic in the treatment of the whole series of fractures during the ten years was 1,164. Out of the 1,325 cases open operation was carried out in 539, while in 786 no open operation was considered necessary or desirable. Immobilization of the fragments was secured by some method of direct fixation in 229 out of the 539 cases submitted to open operation.

Stating these figures also in percentages, therefore, we find that (1) open operation was carried out in 40.67 per cent. of the whole ten years' series; (2) direct fixation by some mechanical means was employed in 17.28 per cent. of the whole ten years' series; (3) direct fixation was made use of in 42.48 per cent. of the cases treated by open operation, leaving 67.76 per cent. of cases of open operation in which no form of internal mechanical fixation was employed.

Comparison with Earlier Figures.—In my previous paper (British Medical Association, 1922), I gave in tabular form, for comparative purposes, figures from the records of the Broadstone Hospital, Port Glasgow, of which I had the surgical charge during the nine years from 1907 to 1916. I reproduce this table here:

TABLE IV

Cases of Fracture of all kinds treated by Mr. Young at the Broadstone Hospital from 1907 to 1916

	1908	1909	1910	1911	1912	1913	1914	1915	1916	Total for 9 years
Total fractures............	40	54	74	84	90	101	68	82	74	667
Treated by direct fixation.	1	2	6	5	8	1	8	6	3	40
Percentages..............	2.5	3.7	8.1	5.9	8.8	1.0	11.7	7.3	4.05	5.9

It will be seen from this table that, in the nine years' period immediately preceding the ten years' period under present consideration, I had been treating cases of fracture by direct fixation of some kind in about 6 per cent. of all fractures, while we have just seen that the percentage during the ten years' series has advanced to over 17 per cent. This may be taken as a very clear indication of the sincerity of our conviction that direct fixation by open operation has justified itself by its results. Otherwise, our continuance—nay, our increasing employment—of this method of procedure would be difficult to understand.

The Argument from Statistics and Experience.—As I pointed out in my earlier paper, the progressive increase in the proportion of cases dealt with by open operation, and by direct fixation, evinced our increasing confidence in the superiority of these methods over those previously employed. So now, in reviewing the second five years' period by itself, and after combining it with the earlier five years' period, there is clearly brought out the fact that our confidence has been maintained. One is entitled to assume, therefore, and to declare, that increasing experience has but served to stabilize and reinforce our confidence in the methods.

I have been accustomed to advance the further argument in favor of direct fixation by open operation that the continuance, and indeed, the increasing employment of it, can not be explained on the grounds of its simplicity or ease in execution. Indeed, it is far otherwise. Almost any operation for the direct fixation of fractures of the long bones may impose upon the operator and his assistants a considerable strain; may tax his and

their physical energy, endurance and ingenuity to the uttermost. The job is seldom a light or easy one. Any one who has witnessed many open operations of the kind, or who has ever taken part either as principal or assistant in such operations, will readily admit that all concerned must put a great deal of their physical strength and energy into the work; must, indeed, "sweat over it," in a very real and literal sense. Such, indeed, is the demand upon the endurance and physical strength of those concerned that, unless sustained by their conviction of the efficacy and unchallengeable superiority of the open operative procedure, they would be extremely unlikely to continue for long to practice it.

The Various Methods Employed.—In my earlier paper I showed, in tabular form, the different methods employed in respect of all the bones in the first five years' series which were dealt with by direct fixation. The table may be reproduced here.

TABLE V

Showing the bones involved and the different methods of fixation employed in the first five years' series

	Wiring	Pinning	Plating	Screwing	Pin and plate	Ring plates	Total
Lower jaw	7	—	—	—	—	—	7
Clavicle ..	1	—	3	—	—	—	4
Clavicle, outer end	—	1	—	—	—	—	1
Humerus, upper end	—	4	1	—	—	—	5
Humerus, shaft	—	—	6	—	—	—	6
Humerus, lower end (T)	—	—	—	—	2	—	2
Humerus, lower epiphysis	—	16	—	—	—	—	16
Olecranon	5	—	—	—	—	—	5
Ulna	—	3	—	—	—	—	3
Radius	—	—	2	—	—	—	2
Radius and ulna	—	—	2	—	—	—	2
Metacarpal	—	1	—	—	—	—	1
Phalanx, finger	1	1	—	—	—	—	2
Femur, upper end	—	2	—	—	—	—	2
Femur, shaft	—	—	12	2	—	1	15
Patella	4	—	—	—	—	—	4
Tibia	3	—	22	—	—	—	25
Metatarsal	—	1	—	—	—	—	1
Totals	21	29	48	2	2	1	103

The methods included fixation by wire, by different kinds of pins or nails, by screws, and by combinations of these; also, in one case by ring plates.

Reference to the table will show that the total number of cases in the series treated by direct fixation was 103. Of these, twenty-one were treated by wiring, twenty-nine by pinning or nailing, forty-eight by plating, two by screw fixation, two by a combination of plate and pin, and one by ring plates. The bones so treated included the mandible, the clavicle, the humerus, the olecranon, the ulna, radius, metacarpals, phalanges of the fingers, femur, patella, tibia and metatarsals. In a considerable number of cases also, as the table shows, epiphyseal fracture-separations were treated by this method.

including the upper and lower epiphyses of the humerus and the upper epiphysis of the femur.

The second five years' series and the corresponding details, with respect to bones involved and the operative methods employed, are shown in the next table. (Table VI)

TABLE VI

Showing the bones involved and the different methods of fixation employed in the second five years' series

	Wiring	Pinning	Plating	Screwing	Wiring and pinning	Wiring and plating	Wiring and screwing	Metal band	Catgut suture	Total
Mandible	1	—	—	—	—	—	—	—	—	1
Clavicle	1	—	—	—	—	—	—	—	—	3
Clavicle, outer end, or acromio-clavicular joint	—	—	1	—	1	—	—	—	—	2
Humerus, upper end	—	2	—	—	—	1	—	—	—	4
Humerus, shaft	—	2	2	—	—	—	—	—	—	4
Humerus, lower end (T)	—	1	4	—	—	—	—	—	—	3
Humerus, lower epiphysis (Capitellar)	—	6	1	—	—	—	—	—	—	6
Humerus, lower epiphysis (internal condyle)	—	—	—	—	—	1	—	—	—	6
Olecranon	6	6	—	—	—	—	—	—	—	11
Ulna	—	4	—	—	—	1	—	—	—	5
Radius	6	4	8	—	—	—	—	—	—	18
Metacarpal	2	2	—	2	—	—	—	—	—	2
Phalanx, finger	2	—	—	—	—	1	—	—	—	1
Pelvis, ilium	—	1	—	—	—	—	—	1	—	1
Femur, upper end (neck)	—	1	—	—	—	—	—	1	—	3
Femur, shaft	—	3	17	—	—	—	—	—	—	21
Patella	2	—	—	—	—	—	—	2	—	8
Tibia	6	—	24	—	—	—	—	1	—	25
Tibia malleolus	1	—	—	—	—	—	—	—	1	1
Fibula	—	—	—	—	—	—	—	—	—	1
Totals	22	32	60	2	1	3	1	1	4	126

It will be seen, by reference to this table, that the bones dealt with are very much the same as those in the earlier period, and that the numbers of each are not greatly different from the earlier period. It will also be observed, however, that whereas in Table V the columns into which the various methods have been divided are only six in number, in Table VI, the columns have increased to nine in virtue of additional combinations in the mechanical technic of fixation.

The total number of cases dealt with by open operation and direct fixation in the second five years' period amounted to 126 (compare with 103 in the previous period). Of these, twenty-two were treated by wiring, thirty-two were pinned or nailed, sixty were treated by plating, two were fixed by screw, in one case wiring and pinning were employed together, in three cases wiring and plating were combined, in one case wiring and screwing were employed

together, in one case a metal band was used, and in four cases the fixation method involved the use of catgut suture instead of any metallic medium.

In this series, as in the previous one, is included a considerable number of cases of epiphyseal fracture-separations, particularly at the lower end of the humerus, in the treatment of which, where there is anything beyond the most trifling displacement, direct fixation is, in our considered opinion, almost always the only correct line of procedure.

The figures for the two periods of five years have been combined in the following table (Table VII), reference to which will show the details for the consecutive ten years' period.

TABLE VII

Showing the bones involved and the different methods of fixation employed in the combined ten years' series

	Wiring	Pinning	Plating	Screwing	Wiring and pinning	Wiring and plating	Wiring and screwing	Pin and plate	Metal band	Ring plate	Catgut suture	Total
Mandible................	8	—	—	—	—	—	—	—	—	—	—	8
Clavicle.................	2	—	4	—	1	—	—	—	—	—	—	7
Clavicle, outer end, or acromio-clavicular joint.......	—	3	—	—	—	—	—	—	—	—	—	3
Humerus, upper end........	—	6	3	—	—	—	—	—	—	—	—	9
Humerus, shaft...........	—	—	10	—	—	—	—	—	—	—	—	10
Humerus, lower end (T).....	—	1	1	—	—	1	—	2	—	—	—	5
Humerus, lower epiphysis...	—	28	—	—	—	—	—	—	—	—	—	28
Olecranon................	11	4	—	—	—	—	—	—	—	—	1	16
Ulna....................	2	3	3	—	—	—	—	—	—	—	—	8
Radius..................	4	4	10	2	—	1	—	—	1	—	—	20
Radius and ulna..........	—	—	2	—	—	—	—	—	—	—	—	2
Metacarpal..............	—	3	—	—	—	—	—	—	—	—	—	3
Phalanx, finger...........	1	2	—	—	—	—	—	—	—	—	—	3
Pelvis, ilium.............	—	1	—	—	—	—	—	—	—	—	—	1
Femur, upper end (neck)....	—	5	—	—	—	—	—	—	—	—	—	5
Femur, shaft.............	2	—	29	2	—	1	1	—	—	1	—	36
Patella.................	10	—	—	—	—	—	—	—	—	—	2	12
Tibia, shaft..............	4	—	46	—	—	—	—	—	—	—	—	50
Tibia, malleolus..........	—	—	—	—	—	—	—	—	—	—	1	1
Fibula..................	1	—	—	—	—	—	—	—	—	—	—	1
Metatarsal..............	—	1	—	—	—	—	—	—	—	—	—	1
Totals.................	43	61	108	4	1	3	1	2	1	1	4	229

As this table shows, the total number of cases treated by open operation and direct fixation in the ten years from May, 1917, to May, 1927 amounted to 229. Of this number, forty-three were wired, sixty-one were pinned or nailed, in 108 cases plating was employed, and the remaining seventeen were dealt with by various combinations of metallic fixation, or by catgut suture. The applicability of particular methods to particular bones will be referred to later.

Further Statistical Details Respecting the Second Five Years' Period.—It will be remembered that the total number of cases of fracture in the second

five years' series was 632. This number, of course, has reference to patients : it does not represent the number of bones fractured. An analysis of the records, indeed, brings out the fact that in these 632 patients, 912 different bones were affected, and in respect of the ribs, metacarpals, metatarsals and phalanges, even this number would require to be considerably augmented.

I have shown in a further table (Table VIII) an analysis of the series, taking 912 as the number of bones involved instead of the 632 patients affected.

TABLE VIII

Showing the total numbers of bones involved in the second five years' period—with relative particulars

	Total fractures	Treated without open operation	Treated by open operation without direct fixation	Treated by direct fixation	Percentages for each bone treated by direct fixation
Skull, vault..................	34	9	25	—	—
Skull, base..................	68	44	24	—	—
Nasal bones................	15	4	11	—	—
Maxilla.·..................	1	—	1	—	—
Malar......................	5	2	3	—	—
Mandible...................	9	2	6	1	11.1
Ribs (multiple).............	54	46	8	—	—
Sternum....................	2	2	—	—	—
Clavicle....................	28	23	2	3	10.7
Acromio-clavicular joint (Fracture dislocation)...........	2	—	—	2	100
Scapula....................	7	7	—	—	—
Humerus...................	75	46	6	23	30.6
Olecranon..................	14	2	1	11	71.4
Radius.....................	94	59	17	18	19.1
Ulna.......................	61	41	15	5	8.2
Metacarpals (multiple).......	13	2	9	2	15.1
Scaphoid...................	4	2	2	—	—
Semilunar..................	2	—	2	—	—
Phalanges, fingers (multiple)..	42	1	40	1	2.4
Spine......................	11	8	3	—	—
Pelvis.....................	26	16	9	1	3.8
Coccyx....................	1	—	1	—	—
Femur.....................	71	39	8	24	33.8
Patella....................	12	3	1	8	66.6
Tibia......................	111	68	17	26	23.4
Fibula.....................	108	96	11	1	.9
Tarsus, various.............	4	2	2	—	—
Astragalus.................	3	3	—	—	—
Os calcis..................	13	12	1	—	—
Metatarsals (multiple).......	18	11	7	—	—
Phalanges, toes (multiple)....	4	2	2	—	—
Totals..................	912	552	234	126	—

In this table the first column shows the numbers for the particular bones. The second column gives the numbers in which no open operation was employed. In the third column are shown the numbers for the particular bones in which some form of open operation was carried out, but in which no mechanical, direct fixation was employed. The fourth column gives the numbers of those treated by direct fixation, and in the last column are the

percentages in the case of each bone where some form of direct fixation was employed.

It will be observed, by reference to the last column of Table VIII, that, in the case of the bones treated by direct fixation, the percentage frequency of application varies within wide limits. The percentages for each bone, as shown in this column, have been arranged in a further table (Table IX), showing the respective frequency in ascending progression. The result of this analysis works out very much as one would have expected, especially as indicating that the bones most frequently dealt with by direct fixation, apart from certain fractures at the outer end of the clavicle and fracture-dislocations of the acromio-clavicular joint, are the olecranon 71.4 per cent., the patella 66.6 per cent., the femur 33.8 per cent., the humerus 30.6 per cent., the tibia 23.4 per cent., and the radius 19.1 per cent. The percentages in these are based on considerable numbers. The lower percentages in the remaining bones, except in the case of the phalanges, are based on much smaller numbers.

TABLE IX

Showing percentage frequency of employment of direct fixation by open operation in respective bones, in the second five years' period—arranged in ascending progression

Fibula	.9
Phalanges, fingers	2.4
Pelvis	3.8
Ulna	8.2
Clavicle	10.7
Mandible	11.1
Metacarpals	15.1
Radius	19.1
Tibia	23.4
Humerus	30.6
Femur	33.8
Patella	66.6
Olecranon	71.4
Acromio-clavicular joint (Fracture-dislocation)	100.0

The Choice of Method.—Reference to the various tables indicates that, in the great majority of fractures of the long bones, one or other of three different methods has been employed, namely, *wiring, pinning,* or *plating.* The cases dealt with by these three methods have far out-numbered all the others put together.

The actual choice of method must always depend on the judgment of the particular operator in the particular case. He will be influenced in his decision by various factors. His purpose is, or should be, to secure the most adequate restoration of function with the minimum of risk, and the maximum of accuracy in the adjustment of the fragments. He will be swayed by anatomical considerations. He will in some cases be prevented from adopting a particular method, which otherwise he might desire to employ, by conditions imposed on him by such anatomical considerations. He must not risk undue

interference with the local circulation, or with important nerve supply, in the course of the adequate exposure of the bone fragments which he desires to readjust and to fix in proper alignment. He may require therefore, in some cases, to choose a method which does not adequately meet his wishes, and to rest content it may be, with something a good deal short of the ideal. The

A   B

Fig. 1.—Fracture separation of olecranon epiphysis—wired.

"second" best, indeed may in certain circumstances be the method of election. He must nevertheless endeavor, where possible, to obtain as perfect alignment and restoration of the anatomical normal as are within his power; for, other things being equal, correct alignment is one of the most important pre-requisites for perfect functional restoration.

A   B

Fig. 2 —Fracture of olecranon—wired.

Wiring.—It will be seen that in each of the five years' periods the number of cases dealt with by wiring alone represents roughly a *fifth* of the whole. The bones to which this method of treatment has chiefly been applied have been the mandible, the olecranon [Figs. 1 (A and B); 2 (A and B); and 3], the patella [Figs. 4 (A and B)], and the clavicle [Figs. 5 (A and B)]. It seems likely that these bones will continue to be the ones in which this method of treatment will most frequently be employed.

The chief difficulty with which the surgeon has had to contend in the wiring of fractures has generally been due to the unsatisfactory quality of

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the wire used. It may be said that this should be as fine as possible, consistent with the necessary tensile strength for the particular case in which

Fig 3 —Fracture of olecranon—wired

it is employed. In the earlier years, when wiring of bones began to be practiced, silver wire was chiefly used, but this was generally found to be

A   B

Fig 4 —Fracture of patella with wide separation—wired

unsatisfactory unless a very thick wire was employed. The finer grades of silver wire were very apt to break at the twist point when anything like the

requisite firmness of application was attempted, and it must have been the experience of most surgeons to have such an accident occur frequently at the most critical stage in the procedure.

Many other types of wire have, in consequence, been tried in the endeavor to obtain a material which will normally withstand the strains for which silver wire has so often proved itself unsuitable. In my previous paper I indicated that I had been using, for a considerable time, a brass wire which seemed to meet the requirements of its effective use much more adequately than silver wire, and I exhibited, to the surgical section of the British Medical Association, samples of this brass wire in different grades, most of them of comparative thinness. I have continued using brass wire, and on the whole have found it greatly more satisfactory than silver wire. On the same occasion I mentioned, and showed to the section, samples of other types of wire: nickel, and monel metal (an alloy of copper and nickel in the
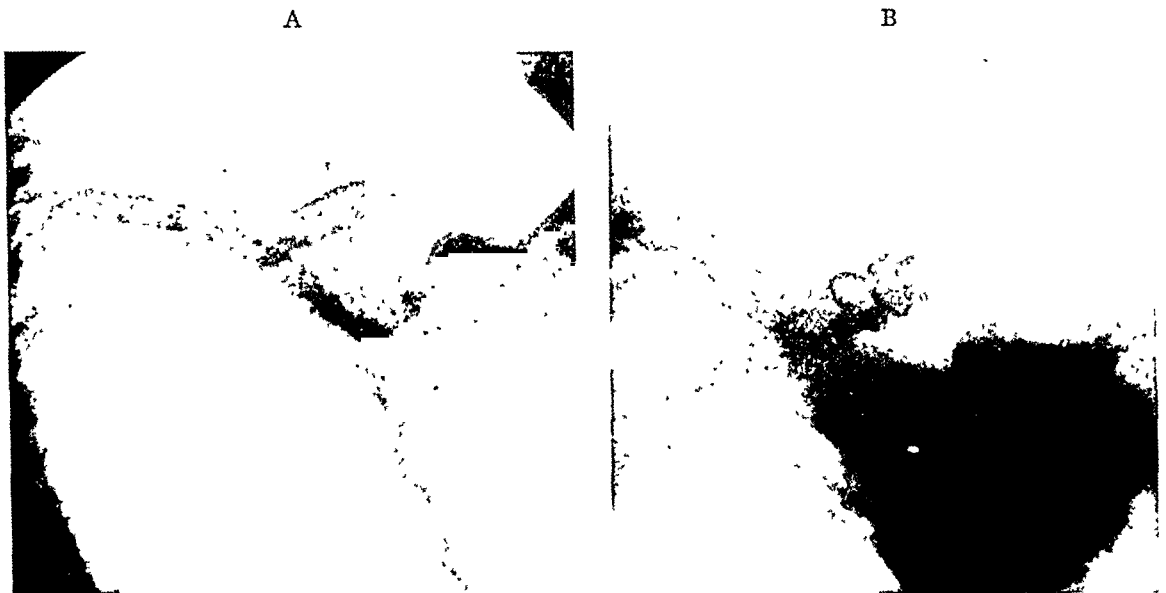
FIG. 5.—Fracture of clavicle, with separation and downward tilting of a central fragment. Replacement by open operation, and fixation by wiring.

proportion of 67 per cent. copper and 33 per cent. nickel). Neither of these wires has proved itself so satisfactory as the simple brass wire, and I have not found that the brass wire exerts upon the tissues any obvious harmful effect. Nor have I found that it is acted upon by the tissues to any appreciable extent.

This brass wire—and even the finest grades of it—is strong, pliable, and easy of employment. If used with care it can be twisted to the point of absolute stabilization with the minimum of risk of snapping. It is suitable both for the direct fixation of bone fragments, and in the case of fractures of the mandible, for the wiring of teeth. This is particularly important where the teeth are so closely set that the difficulty of wiring them together would be greatly enhanced if one were under the necessity of using a thick wire such as silver. The fine-grade brass wire can be slipped very easily between even fairly closely set teeth. and can be wound several times round and between the adjacent teeth which one desires to utilize as fixation points.

In my previous paper I referred to a case of fracture of the mandible, and showed a radiogram from the case, in which the bone fragments were directly fixed by means of a single fine wire; the fixation was absolute, and the alignment as nearly perfect as possible. One can hardly imagine the possibility of achieving such a result with a single silver wire, twisted to the degree necessary to produce absolute stabilization, without the wire snapping. (Fig. 6)

The fixation of the fragments of a fractured mandible by wiring of the adjacent teeth is illustrated in Fig. 7.

In addition to the employment of wiring by itself, we have made use of it, during the second five years' period, also in combination with other methods. Reference to Table VI will show that we have employed it along with pinning, with plating, and with fixation by screws. It is likely that we shall

FIG. 6.—Fracture of mandible, showing how fixation was effectively secured by a single fine brass wire. No external splint was employed.

FIG. 7.—Fracture of the mandible. Fixation by wiring of teeth.

continue to employ it, from time to time in selected cases, along with other methods.

It is obvious that in certain fractures of the long bones, such as femur, or humerus, or in fractures in which one or more small but essential fragments have been partially detached from the main fragments, the use of one or more wires penetrating or encircling the main and subsidiary fragments is a reasonable procedure. One could give several illustrative examples from our experience—examples both of simple wiring and of the uses of wiring in supplement to other methods of fixation.

Pinning or Nailing.—As in the first five years' period, so also in the second, the number of cases treated by this method has been considerable, amounting to roughly *a quarter* of all the cases operated on by direct fixation. In my former paper, I described the different kinds of nails or pins which we had been accustomed to employ. (Fig. 8) In the earlier years, we used relatively thick and heavy nickel or silver-plated steel pins of vary-

ing length, and very much of the same type as we had been in the habit of employing for fixation purposes after resection of the knee.

For certain purposes we still employ, and must continue to employ, nails of this character—relatively thick, strong, and sometimes of considerable length; even as much as four or five inches.
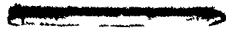
Older Forms of Pin used,
and still employed,
for
Special Purposes.

Different Forms of
fine nail, or
"sprig,"
used in fixing
separated
Epiphyses, &c.
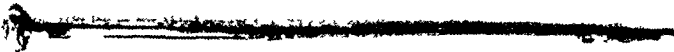
Pin actually used in
Pinning Fracture of
Neck of Femur.
(Observe, in this case,
and in the next, below,
the absorption of the tip).

Pin actually employed in
Pinning Separated Head
of Femur.

Fig. 8.—Showing different kinds of the larger steel pins and the finer "sprigs" employed. At the lower part of the figure are shown two long steel pins, actually used in fixing fractures of the neck of the femur. Note the absorption of their tips.

Nails of this character we continue to use in certain fractures of the upper femoral epiphysis or fractures of the neck of the femur, particularly intracapsular fractures with minimal fragmentation or comminution. In suitable cases the use of a single long pin of this character furnishes a simple

and effective means of fixing the detached articular head to the separated neck or upper end of diaphysis. It is seldom desirable to attempt to do this without making a free opening into the hip joint from the front, the fragments being adjusted as accurately as possible, and set into proper relation with each other, before the long pin is introduced. We have generally exposed the joint through an anterior incision, very much like the one used in

A
B

C
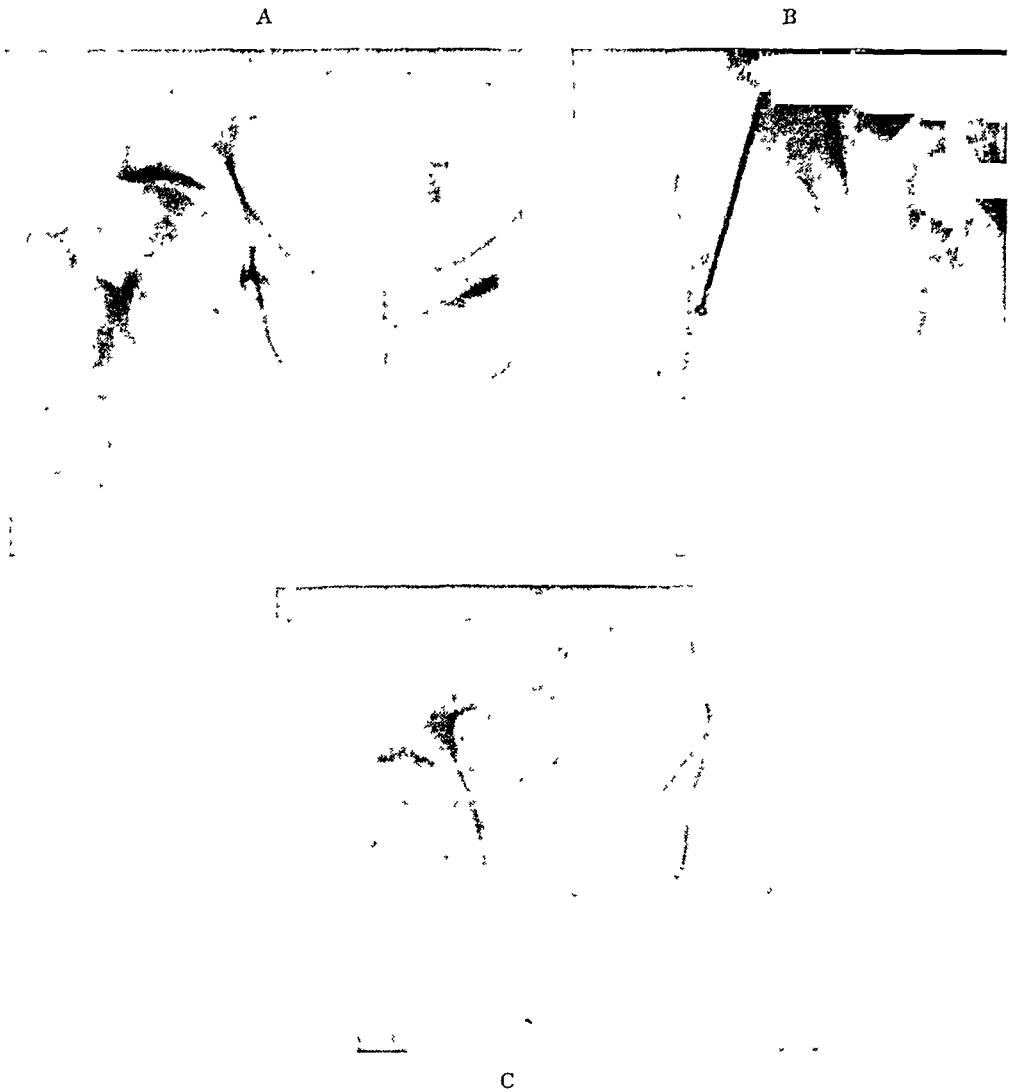
FIG. 9.—Fracure of the neck of the femur. Fixation by a long steel pin passed from the diaphysis upwards along the neck into the femoral head: (A) Showing fracture and displacement; (B) Showing nail in position, after replacement; (C) Three months after—union complete.

Barker's method of excision of the hip. This gives free and adequate exposure of the joint and of the fractured neck, and once the right degree of adjustment has been secured, the nail is introduced through a separate puncture of the skin on the outer surface of the limb, at a point an inch or two below the tip of the great trochanter. From there, it is driven as nearly as possible axially along the femoral neck, until it penetrates the main articular

fragment. Into this it is driven firmly by light taps of a hammer. The head of the pin or nail is left projecting through the skin puncture until the nail has served its purpose—say, after six or eight weeks—when it is easily removed. We have employed this method in fractures at the upper end of the femur in three cases in the second series, and more recently still in several other cases of the same kind. I know of no other method which has proved itself, in our hands, so satisfactory as this is in the treatment of such injuries. [Figs. 9 (A, B, and C.)]

In similar fractures, or epiphyseal separations, at the upper end of the humerus, we have quite often fixed epiphysis and diaphysis, or proximal and distal fragment, effectively together by the use of a single long pin or nail, introducing it in some cases from below upwards, and in others from

A   B
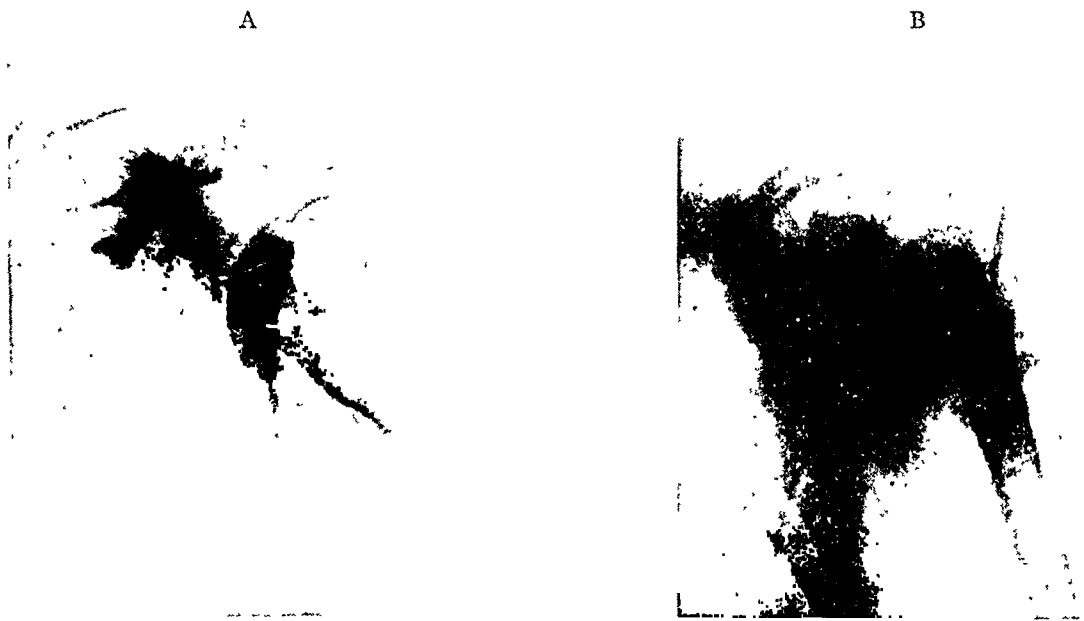
FIG. 10.—Fracture of upper end of humerus in an adult woman: (A) Showing gross displacement of distal fragment into axilla; (B) Replacement and fixation by a long pin passed from the proximal fragment into the distal. (Dr. A. J. Hutton.)

above downwards, i.e., from diaphysis below driven obliquely upwards and inwards into the articular head, or from the epiphysis or upper end of the humerus downwards and inwards into the diaphysis. Both methods we can readily illustrate from our records of this and of the previous five years' period. [Figs. 10 (A and B); 11 (A and B)]

Occasionally a second nail of equal length may be required in order to accomplish the necessary degree of effective fixation, and in one case we actually employed three of these long pins before we were satisfied that we had obtained sufficiently stable fixation.

In my earlier paper I alluded to a special little group of injuries in the region of the outer end of the clavicle and the acromio-clavicular joint, where very satisfactory fixation and alignment of fragments could be obtained by means of the introduction of a single long steel nail, and I illustrated one of these. I refer, in particular, to those fractures of the extreme outer end of the clavicle, where replacement and fixation of the small distal or acromial

fragment are difficult, and in some cases practically impossible of accomplishment by ordinary means. The method of application is simple.

The fracture area is exposed through a suitable, but small incision. The fragments are adjusted, and are maintained by simple means in their normal

A   B

Fig 11 —Fractuie of upper end of humeius   (A) Showing gross outward and upward displacement of distal fragment, (B) Replacement and fixation by a long pin passed upwards from distal fiagment into the proximal

relation to each other, while a long steel pin of this strong type is passed through a small puncture made in the skin, external to the acromion, axially right through the outer fragment and on into the shaft of the clavicle. If necessary it may perforate the acromion and traverse the acromio-clavicular

A   B

Fig 12 —Fracture of the outer end of the clavicle in an adult male· (A) Showing gross displacement, (B) Correction by open operation, and fixation by a long steel pin.

joint before perforating either of the clavicular fragments. [Figs. 12 (A and B)]

This same method we have employed, on a number of occasions, to prevent or control the troublesome upward displacement of the acromial end of the clavicle in the not uncommon dislocation at the acromio-clavicular joint. As I said before, I know of no equally effective method of controlling the upward rising acromial end of the clavicle. Fixation by plate and screws, or by simple pinning, or by wiring, is of little use. The introduction of the

simple long steel pin in the manner that I have described has proved itself in our hands to be easy, effective and satisfactory. Nor does it, as might be supposed, interfere to any appreciable degree with the function and useful movement one desires to preserve at this joint. [Figs. 13 (A and B)]

A   B
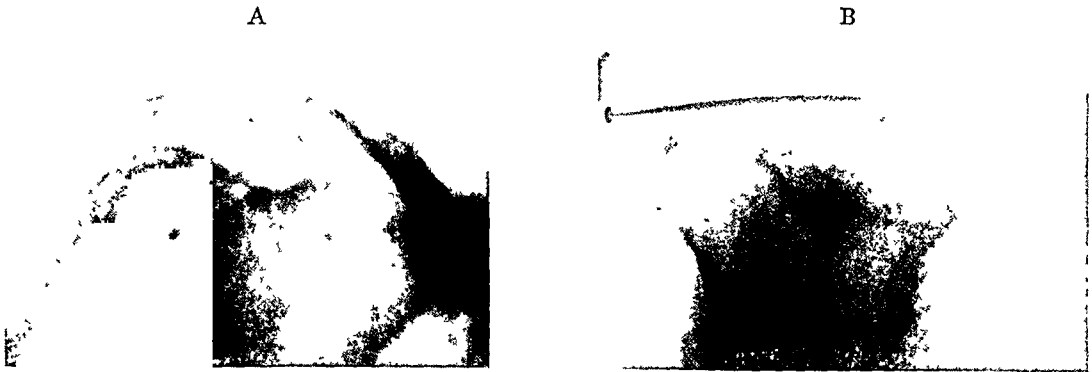
FIG. 13.—Dislocation at acromio-clavicular joint: (A) Showing gross upward displacement of acromial end of the clavicle; (B) Correction by open operation, and fixation by a long steel pin.

Both in the case of fractures of the outer end of the clavicle, and in dislocation of the acromio-clavicular joint, the pin has served its purpose and may be withdrawn with safety at the end of three or four weeks.

Another type of injury in which we have found the use of such a long steel pin to be very effective is the troublesome T-shaped fracture at the lower end of the humerus. We have found great difficulty sometimes in

A   B   C
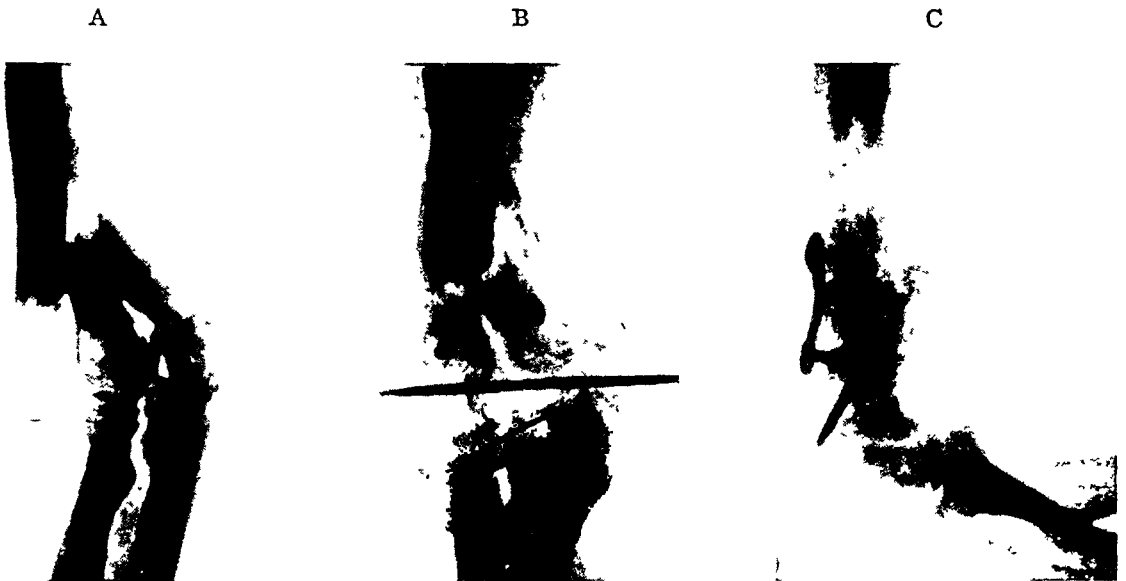
FIG. 14.—Fracture of lower end of humerus in a young adult male—T-shaped, into elbow joint: (A) Showing the gross displacement of fragments; (B) After pinning and plating (anterior-posterior view); (C) The same in profile.

maintaining the two lower fragments in proper apposition during the introduction of the plate or plates required to secure them to the diaphyseal fragment. They tend to rotate on their long axes, no doubt as the result of the attachment to each of one or other of the two main groups of forearm muscles, namely, the flexor-pronator and extensor muscles respectively. This difficulty is got over by first of all passing a long steel pin from side to side, right through both fragments. This effectively steadies them, and

the plates and screws can then be applied with less difficulty. This was well illustrated in my earlier paper, and the illustrations may be reproduced here. [Figs. 14 (A, B and C)]

With these exceptions, however, it may be said that we have come to employ, in most cases, much finer nails or pins. For most purposes the larger and thicker pins or nails are quite unsuitable: they are very apt to

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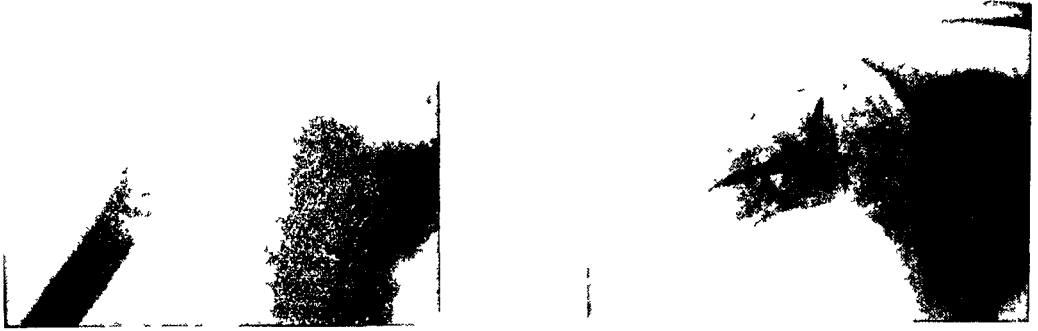
FIG. 15 —Fracture of upper end of humerus (A) Showing impaction of distal fragment into the proximal, (B) After correction, and fixation by three fine "sprigs"

cause splitting of the fragments into which they are driven unless these fragments are previously drilled for their reception. In many cases they are obviously much too bulky; they require, for their introduction, the expenditure of much greater force than seems to be justifiable; and there is a good deal of scattering of bone dust into the surrounding tissues during the process of drilling. Nor do they give any more effective fixation than do the finer agents which we now very largely employ. [Fig. 15 (A and B)]

This is particularly the case in those fractures or fracture-separations of the lower epiphyses of the humerus which we now treat so generally by open operation and direct fixation. In the case of these injuries very little is required to fix the fragments, and the finest steel pins or "sprigs" are as effective as could be desired. We use these of varying length, from three-quarters of an inch in length up to, at the most, an inch and a half. They are the ordinary "sprigs" or "fine wire nails" used by the carpenter, and as a matter of fact, we obtain them from the infirmary carpenter from time to time as we require them. Their cost is practically "nil"; we use them unplated; and in many cases, they are left permanently buried in the bone where they do no harm.

FIG 16 —Fracture of upper end of ulna Fixation by a single fine "sprig"

We have used them in many other situations as well; in fractures of the

olecranon, of the forearm bones, of the upper end of the humerus, in fixation of malleolar fractures, and also in a certain number of· fractures of the

A   B
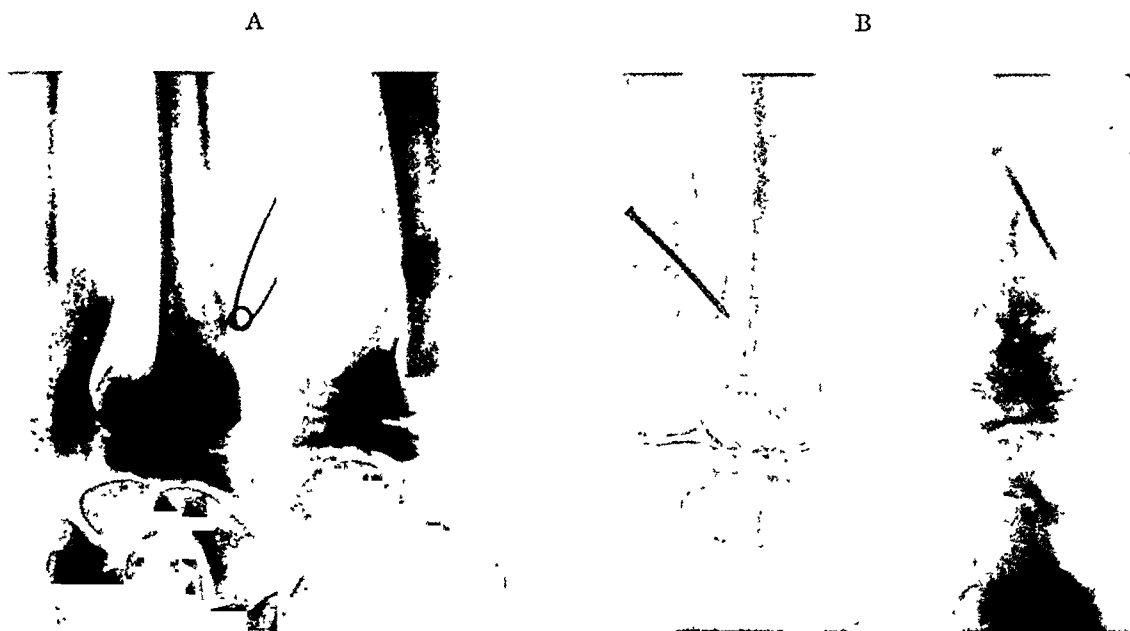
FIG. 17.—Fracture of both bones of forearm near the lower end: (A) Showing gross displacement of the fragments (anterior, posterior and profile views); (B) Result after correction by open operation, and fixation of the ulnar fragments by a single fine "sprig" (anterior, posterior and profile views).

phalanges of the fingers, and in fractures of the metacarpals and metatarsals, the pin being introduced axially from one fragment into and along the other, and being left as a permanent central axis in the realigned bone. It does no harm in its new bed. [Figs. 16, 17 (A and B), and 18]

This axial implantation of a fine nail or "sprig" I have employed also in certain cases of fracture of the clavicle, alone, or in combination with circular wiring.

As I pointed out in my former paper these finer pins or nails, which are sometimes of the rounded type, and sometimes flattened in section, head as well as nail length, have the advantage that they do not readily split the fragile fragments into which they are introduced; that they do the minimum of damage to epiphyseal cartilage and growth centres; and that they are generally so easily driven home. In the comparatively soft bone of a young person such fine pins can often be driven well home without any preliminary

FIG. 18.—Fracture-separation, distal epiphysis of the radius, with gross displacement. Correction and fixation by a single fine "sprig."

drilling, and without the application of much force. As a rule, a few light taps with the heavy end of a periosteal elevator or with a light hammer may be required, but that is all.

In the second five years' series the bones which have been treated by simple pinning have been clavicle, humerus, olecranon, radius, metacarpal, phalanx of the finger, pelvis and the upper end of femur.

Plating.—As in the first series, so also in the second, the number of cases dealt with by plating has been much larger than the number of these treated by any of the other methods. They have amounted, in fact, to almost *half* of the total. Femur and tibia have been plated most frequently of all. The tibia was plated twenty-four times, the shaft of the femur seventeen times, *the radius eight times, the shaft of the humerus four times, the ulna three times, the upper end of the humerus twice, the lower end once, and the clavicle once.*

This method has been so long in use, and in proper hands has given so

A   B
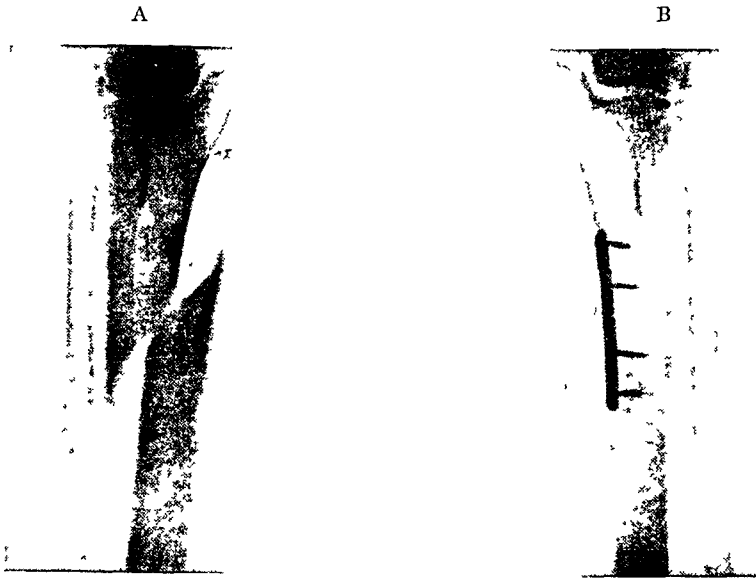
FIG. 19 —Spiral fracture of the lower third of tibia. Fixation by plate and screws (The fibula, broken in the upper third, required no special treatment) (A) Showing the long, oblique, spiral fracture of the tibia, with longitudinal splitting of the distal fragment; (B) Showing the "hair-line" adjustment of the plated fragments.

satisfactory results that little further need be said here regarding it. I offered the opinion, in 1922, that it was probable that the expedient of plating would tend to become confined more and more to the treatment of fractures of the tibia, the femur and humerus. The experience of the second five years would seem to bear out this prophecy, except that the bones of the forearm may require to be added. I took the view, and I see no reason to alter it now, that, in the case of most of the other bones, wiring or pinning would probably become the operation of choice. [Figs. 19 (A and B) ; 20 (A and B) ; 21 (A and B)]

Our practice in respect of the later removal, or not, of the plate and screws is not according to any fixed or hard-and-fast rule. We seldom remove a plate which has been used in fixing a fracture of the femur. Deeply buried as it is beneath the bulky muscles of the thigh, it seldom gives rise to any trouble, and we do not, as a rule, contemplate requiring to remove it.

A   B
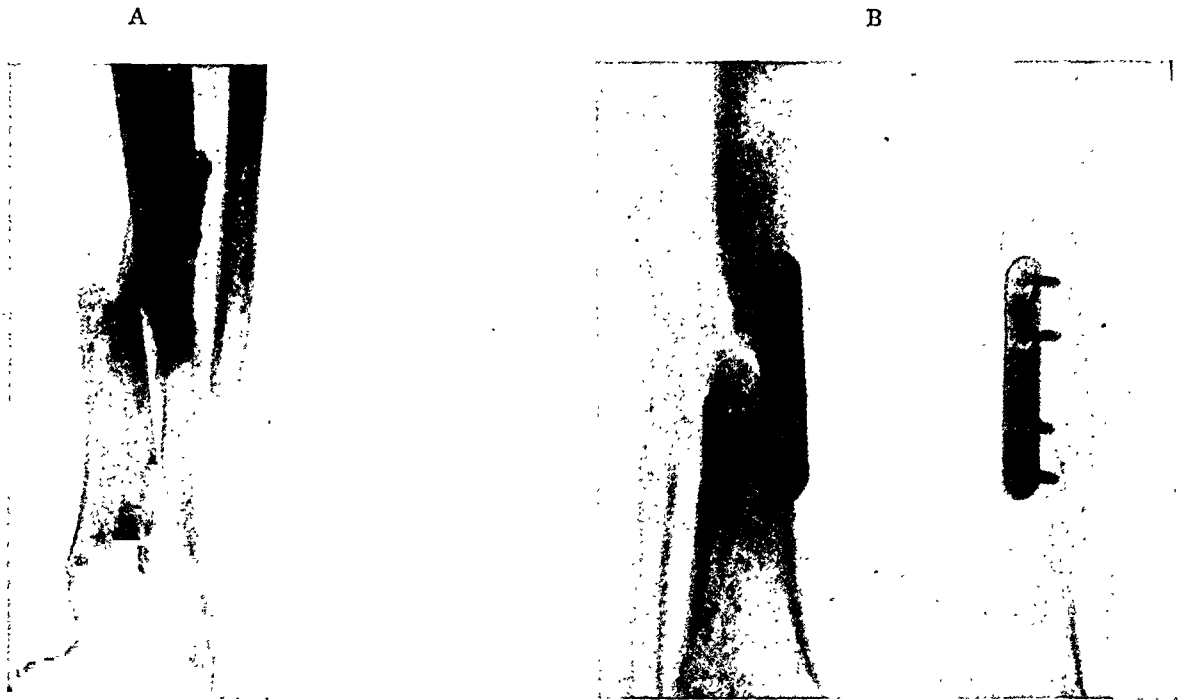
FIG. 20.—Severe compound, comminuted fracture of tibia and fibula. Caused by direct violence. Treated for some months in another hospital. Gross displacement of fragments, and greatly delayed union.

 Open operation, and fixation of the main tibia fragments by plate and screws. The fibular fracture was exposed through a separate wound, and portions of both fibular fragments had to be removed to permit of the tibial fragments being adjusted. A V-shaped gap on the fibular aspect of the tibia was filled in by bone chips. The resul was excellent. (A) Showing the gross displacement of fragments; (B) The satisfactory adjustment, and fixation of the tibial fragments.

A   B
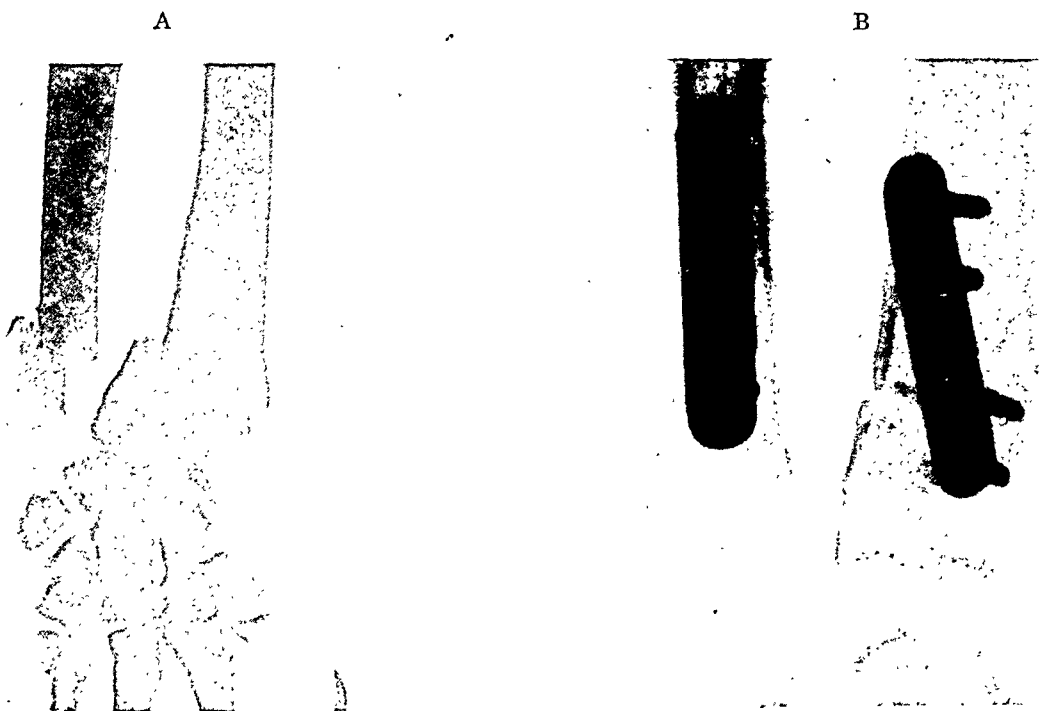
FIG. 21.—Mal-united fracture of the distal ends of radius and ulna. Injury nine weeks before the patient came under observation. Caused by direct violence.

 Open operation, and fixation by plating of both bones through separate incisions. (An excellent functional and æsthetic result.) (A) Showing gross displacement of fragments; (B) Showing the readjustment, and fixation by plates.

On the other hand, in the case of the tibia, which for so considerable a part of its length is practically subcutaneous, we quite often remove the plate and screws as a procedure of choice once the immediate purpose of its introduction—namely, the accurate maintenance of correct alignment while repair processes are going on—has been secured. In the case of an artisan, whose return to work at the earliest possible period is desired, and who is in the course of his work, exposed to many chances of minor injury to the leg, we frequently remove the plate and screws within a couple of months of their introduction. In the case of other bones the retention or removal of the plate is determined according to factors which vary for the particular individual, and with social and other circumstances.

Screwing.—In the first five years' series were included two cases in

A   B
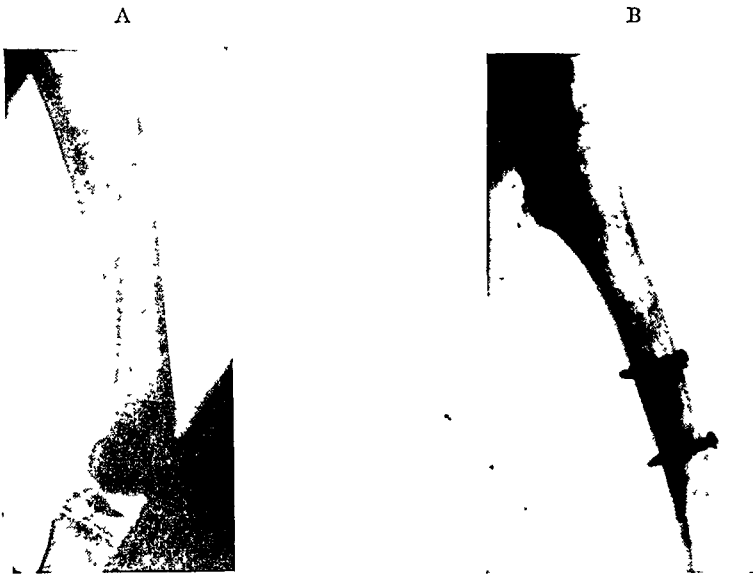
Fig. 22.—Long oblique fracture of the shaft of the femur in a young girl: (A) Showing the gross displacement; (B) Correction by open operation, and fixation by two screws.

which long, oblique, spiral fractures of the shaft of the femur were secured by screws alone. In one case a single screw was employed, and it was quite effective. In the other case, two screws were introduced a very short distance apart. Both cases did well. An illustration from one of the cases is worthy of reproduction here; it shows well the perfect readjustment and re-alignment of the fragments in a very nasty, oblique, spiral fracture of the femur of a young girl. [Figs. 22 (A and B)]

In the second series only two cases were treated by screwing (in both the bone was the radius). I may say here that, in the three years since the expiration of that second five years' period, we have employed the method on several other occasions for fractures of the femur, and with satisfaction.

Combined and Other Methods.—In the section dealing with pinning, reference has already been made to the combination of wiring with pinning in the treatment of certain fractures of the clavicle. In this series, wiring has been combined with plating. [Figs. 23 (A and B)]

This combination was employed also in T-shaped fracture of the lower end of the humerus, in fracture of the radius, and in a very badly com-

A   B

Fig. 23.—Comminuted fracture of the clavicle, with separation and tilting downwards of detached central fragment.
Open operation. Fragments freed. Two main fragments united by fine bridge-plate; gap made up by replacement of the central fragment, which was projected downwards in dangerous proximity to the vessels, etc. This was fixed in position by three fine brass encircling wires. The result was excellent. (A) Showing the gross displacement, and the downward tilting of the central fragment; (B) After treatment by open operation, and fixation by plate and encircling wires.

minuted fracture at the upper end of the shaft of the femur. An X-ray illustration of this last case shows very well the effective readjustment of a very complicated comminuted fracture which we were able to obtain by

A   B
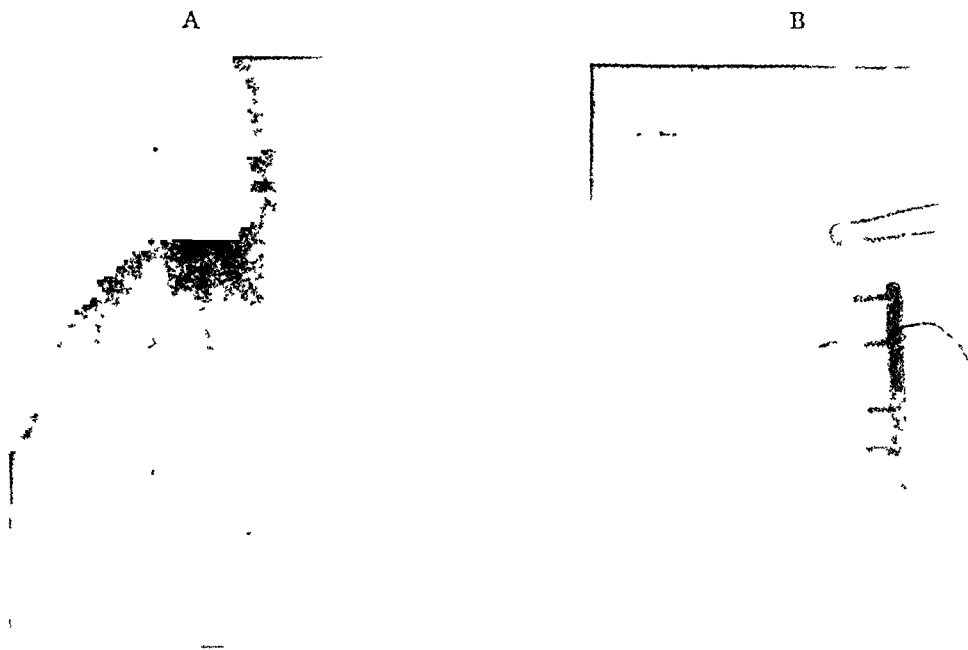
Fig. 24.—Fracture of the upper end of the shaft of the femur, with extensive comminution, longitudinal splitting of he bone, and wide separation of the fragments, one of which included the lesser trochanter.
Open operation. Replacement of the fragments in good alignment, and fixation by plate and screws, and three encircling wires. (A) Showing wide displacement of fragments, (B) After replacement, and fixation

this means. [Figs. 24 (A and B)] In one case, a fracture of the shaft of the femur, wiring was used in combination with screwing.

In a single case operated upon in my wards by a colleague, a fractured

ulna was effectively secured by the application of a metal band around the site of fracture. (Fig. 25)

In four cases in the second five years' series, fixation was secured without the use of any metallic medium. The agent employed was catgut. As might be expected, two of these cases were fractures of the patella, one was a fracture of the olecranon, and one a fracture of the tibial malleolus. In the case of patella and olecranon the catgut sutures were passed through the bone fragments just as one might have passed metallic wire, but they were supplemented by additional catgut sutures passed superficially and laterally, in such a manner as to secure the closely related and damaged aponeurotic covering and the lateral aponeurotic expansions of quadriceps or triceps. In the case of the malleolar fracture the catgut sutures were entirely superficial.

Special Applicability of Direct Fixation to Particular Bones.—From consideration of the foregoing, and from the relative tables, it is obvious that direct fixation by open operation as anything like a routine procedure, is
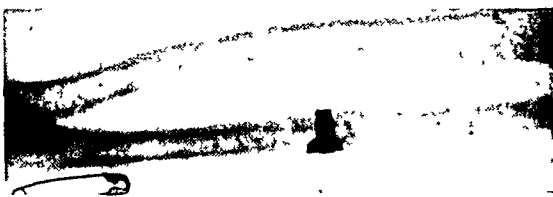
Fig 25.—Fracture of both bones of the forearm—the radius in the upper third, with practically no displacement, and the ulna at the middle of the shaft. Replacement of the ulnar fragments, and fixation by a single metal band. (Radiograph—nine years after.)

specially applicable to a somewhat limited group of bones. These are the olecranon, the patella, the femur, the humerus, the tibia, the radius (and, to a lesser extent, the shaft of the ulna). Less frequently, fractures of the clavicle, the mandible, and the shorter long bones, such as the metacarpals and phalanges, call for operative interference and for the adoption of some simple method of internal fixation.

The particular method, or combinations of methods, to be adopted in any given case will vary widely with factors of different kinds. Some of these have been already referred to, and the subject therefore calls for no further elaboration here.

Indications for Adoption of Open Operation and Direct Fixation.—In my earliest communication on this subject, before the section of surgery of the British Medical Association twenty years ago, I suggested a number of principles which should guide one in deciding upon open operation in any given case of fracture. These were as follows:

First of all, and of chief importance, the obliquity of a fracture. In the case of the leg, or the thigh, this factor should in a large proportion of cases determine the adoption of open operation. I still believe that in great measure this condition still holds good. In no other way can one obtain the absolute correctness of apposition and alignment which one desires. In no other way can one assure the removal of diffused blood, and the adequate freeing of muscles and tendons, which mean so much in the ultimate restoration of function. The artificial fixation of the fragments at the same time,

by plates, wire, or other means, renders the case so much more easy to nurse. Pain is at once relieved, and the period of incapacity ought to be substantially shortened. What has been said of oblique fractures of the leg and thigh I believe to be true also of most similar fractures of the shaft of the humerus, and of a considerable proportion of fractures at its upper end.

Secondly, the presence of any considerable quantity of extravasated blood. This I still believe to be an important indication for open operation, especially if it is combined with much comminution of bone, or substantial displacement of fragments. Such accompaniments are almost certain to determine the production of excessive callus around the seat of fracture, no matter how effectively without open operation these may be adjusted; and such excessive callus and irregular bony growth must necessarily greatly prejudice the recovery of function. The troublesome myositis ossificans in the neighborhood of certain fractures, especially fractures of a comminuted type, and especially where these are in the neighborhood of the more important larger joints, is probably due in great measure to the distribution of bone dust and débris—with their accompanying osteoblasts—throughout the clot and into surrounding intermuscular planes and muscular substance. The free removal of all the intervening and surrounding blood clot, and of the potentially callus-producing and bone-forming material contained in it, is most desirable from the point of view of future function.

Thirdly, failure to elicit satisfactory crepitus. This third condition or guide should require merely to be mentioned in order to justify itself. Take the case of a fracture of the shaft of the femur. If one is unable to elicit, even under anæsthesia, crepitus of an unmistakable and satisfactory character, one must assume that the fractured surfaces are not in direct contact, and in fact are probably separated from each other by non-bony material such as muscle. It is obvious that failure to remove this intervening material will not only prevent proper alignment, but will probably very materially prejudice the achievement of bony union. This being recognized, and fractures falling within this category being exposed openly, not only will the intervening material be cleared out, but the fixation of the fragments thereafter by direct means will so stabilize them that the possibility of the further interposition of soft tissues will be prevented.

These three indications for open operation and for direct fixation I believe still hold good. Speaking now, twenty years after I first suggested them, I believe they may be taken as quite good guides. They are not the only indications by any means. In particular bones, and in particular circumstances, other principles and other indications will constantly suggest themselves.

Per contra, one is bound to admit that there are, and will remain, still a considerable number of fractures, even of the long bones, such as the femur, tibia, and humerus, that will not call either for open operation or for direct internal fixation, unless as an operation of the patient's choice. Amongst these would be included many simple transverse fractures, espe-

cially those which one might term subperiosteal—i.e., simple transverse breaks of the bone, with the minimum of tearing of its periosteal covering. and hence with minimal and even no displacement.

Direct Fixation in Epiphyseal Fractures, or Fracture-Separations.—As I pointed out in my earlier paper a certain number of epiphyseal injuries call for no open operative interference. There is sometimes very little displacement, and the epiphyseal fragments are often very easily maintained in their correct relation with the diaphysis, either with or without a simple splint. In some such cases of fracture-separation in the region of the elbow in a child, little is required beyond the application of a firm bandage around the flexed elbow, and the controlling of the arm and forearms just sufficiently to prevent more than slight to-and-fro movement. The same may be said of many epiphyseal separations at the distal ends of radius and ulna, and of tibia and fibula. Provided these injuries are not dealt with haphazard, but the actual anatomical relations in each case are from the first properly appreciated, and are checked from time to time by careful X-ray examination, and where necessary the correctness of apposition secured by manipulation under a general anæsthetic, both the æsthetic result and the level of functional restoration should be satisfactory, without any operative interference of an open character.

It is a very different story, however, with those fracture-separations at the lower end of the humerus where displacement of the epiphyseal fragments is at all considerable—and it is often extreme. In such cases open operation, accurate reposition, and direct fixation are, in my opinion, almost always imperatively necessary. In no other way that I know of can one hope to obtain the satisfactory adjustment, and the restoration of full joint function that one ought to strive to obtain.

Not only so, I am quite clearly of the opinion that only by open operation and the accurate readjustment and direct fixation which are then possible, can we secure the conditions—the best conditions—for the preservation with the least possible degree of disturbance of the growth processes in that region. Without such accurate readjustment the normal growth is almost certain to be profoundly disturbed, and we shall have, with the lapse of time, the development of the ugly "gun-stock," or other, deformity which we so much dread.

In respect of these injuries, I have completely recanted from the position which I took up in 1910.[3] At that time I still held to the opinion that most fractures and fracture-separations in the region of the elbow, and particularly those involving the lower end of the humerus, could be effectively dealt with without open operation, and I was accustomed to deal with them in what one might regard as the then orthodox way, so well described and illustrated by Scudder in his textbook.[5] I was of opinion then that the main cause of limitation, or impairment, of function after these injuries was due not so much to incorrect replacement of fragments, but to their re-displacement as the result of premature and injudicious movements of the

joint. The teaching then was that movements of the joint should be begun early, and often forcible movements were carried out either with or without a general anæsthetic. I believed then, and I still believe, that these early forced movements generally did more harm than good, and my practice at that time was to replace the fragments as best I could under an anæsthetic and put up the limb, in the position of flexion at the elbow, in suitable poroplastic molded splints. The state of things was checked by means of the X-rays, and the molded splints were left on for several weeks. After their removal a limited degree of movement was permitted, but not passive or forced movement.

My position now, however, is practically a complete departure from that of 1910. I stated it pretty fully in my former paper dealing with the first five years' period,[4] and I need hardly elaborate it further here, save to say that I profoundly believe that by open operation, accurate replacement, and simple fixation of epiphyseal fragments in injuries of the lower end of the humerus, one is best able to guarantee not merely a good immediate functional result, but also the restoration and continuance of the normal growth processes which will promote the natural growth and development of the limb, and minimize the chance of the subsequent deformity which must inevitably result if epiphyseal and diaphyseal growth are disturbed, or substantially checked.

In his communication in 1910 before the British Medical Association,[6] Lane had indicated that injuries in this region had better perhaps, in most cases, be treated by non-operative means, lest the growth of bone at the epiphyseal line might be interfered with. Experience has shown me, on the contrary, that in spite of the local disturbance contingent upon open operation and direct fixation, such interference with, and disturbance of the growth processes, are less likely than where non-operative treatment is employed, and where, therefore, displaced epiphyseal fragments are not so accurately restored to their proper relations.

In my earlier paper (1922), I cited a very instructive case which seemed to confirm this view. It was that of a young lad upon whom I carried out a resection of the knee for tuberculous disease, and in the course of the operation I had the misfortune to disengage completely the whole lower epiphysis of the femur from the diaphysis. I replaced it and fixed it in position again, but I feared that the accident might lead to suspension of growth—to premature synostosis. To my surprise, this result did not follow. The bone continued to grow equally with the corresponding bone in the other limb, and that this was so, was confirmed long afterwards by comparative X-ray examination, and by periodical measurements of the limb.

I would quote here what I said in 1922.[4] It represents pretty accurately the view which I take to-day:

"I believe that if accurate re-apposition of epiphyseal centres be not brought about, the failure to do so is the very factor that will lead to the growing parts being smothered

in callus, and crushed in new, irregular bone, which will effectually lead to suspension of normal growth at the epiphyseal lines.

"That nothing short of full exposure of the fracture-separation area will suffice, if accurate readjustment is to be accomplished, my now considerable experience of these

A   B

FIG. 26.—Fracture-separation, lower end of humerus, in a boy aged thirteen years. Note the gross displacement backwards of the lower (epiphyseal) fragment, with partial inversion.
Open operation. Replacement of fragments, and fixation by two pins, one of the larger type, and the other a fine "sprig." (A) Showing the displacement of fragments (anterior, posterior and profile views); (B) After replacement and fixation. (In the anterior, posterior view the larger pin has been removed. In the profile view both pins are still in position.)

cases has proved to completeness. I have found the whole lower epiphysis of the humerus so completely displaced as to be tilted in almost unbelievable fashion. I have, on quite a number of occasions, found it almost completely inverted, articular surface looking upwards, and epiphyseal cartilage downwards. [Figs. 26 (A and B)]

"I have found a fragment, including capitellum, part of trochlea, and external epicondyle, so completely tilted on its transverse axis that the articular surface of capi-

A   B
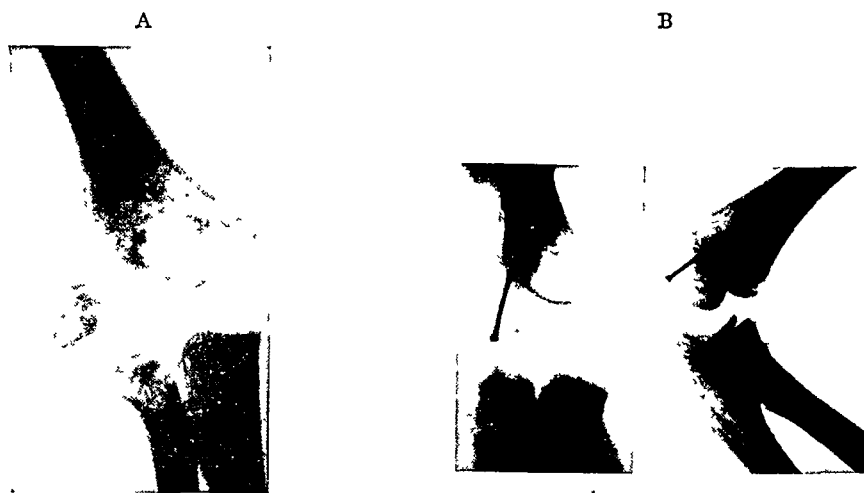
FIG. 27.—Fracture-separation of capitellar epiphysis, lower end of humerus, in a boy aged seven years. Note the gross tilting outwards of the capitellar fragment.
Open operation, replacement of fragments, and fixation by a single fine "sprig." (A) Showing the gross displacement (anterior, posterior view); (B) After replacement, and fixation (anterior, posterior and profile views).

tellum looked directly outwards, while the fractured surface rested against the head of the radius. [Figs. 27 (A and B)] We have had several instances of this.

"Further, separation of the centre for the internal epicondyle, especially if the muscular attachments to it and above it are torn away, means so considerable longitudinal displacement that nothing short of open operation and direct pinning of the fragment in its proper relation can possibly suffice. [Fig. 28 (A and B)]

"In short, the argument in favor of operative treatment of these lower humeral

epiphyseal fracture-separations—open operation, accurate readjustment, and direct fixation—seems to me sound beyond dispute."

The actual method of procedure calls for little comment. The most convenient incision in almost any type of epiphyseal displacement at the elbow, except that of the internal epicondyle alone, is one made on the external aspect of the joint, through which the radio-humeral joint is exposed, and if necessary opened; and the incision may be extended as required in an upward and backward direction. The free exposure which is thus afforded permits, in most cases, of easy readjustment of the fragments, and of the accurate reproduction of their correct anatomical relations. Once
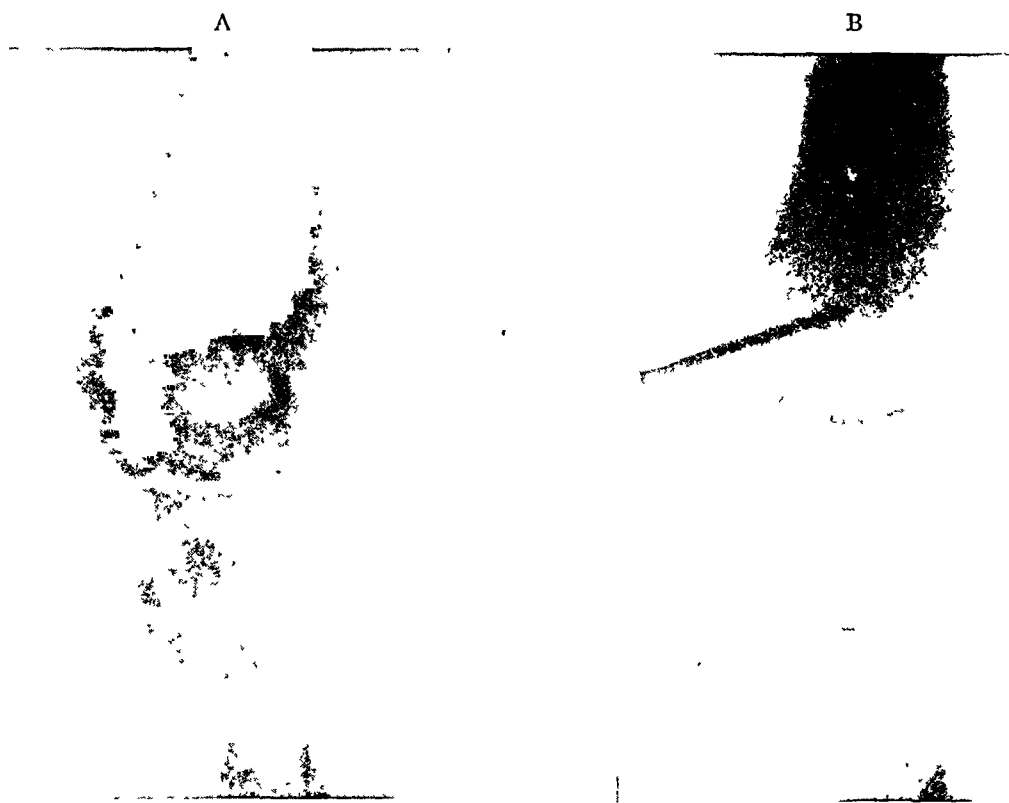
FIG. 28.—Fracture-separation of the epiphysis for the internal epicondyle of the humerus, in a boy aged ten years. Considerable separation of the epicondylar fragment.
Open operation. Replacement of separated fragment, and fixation by a single fine "sprig."
(A) Showing the displacement of fragment; (B) After replacement, and fixation.

reduced, the fragments are readily fixed by one or two of the fine "sprigs" to which I alluded in the earlier part of this paper. They are readily pushed home, and are generally passed from the lower or distal fragment obliquely upwards into the lower end of the diaphysis. In some cases finger pressure alone is sufficient, while in others a few light taps with a hammer or punch may be required. The wound is closed completely, without drainage, and the limb is put up in a partially flexed position. It is placed for a few days on a simple splint, and thereafter a light plaster of Paris sheath is applied. This is removed within two or three weeks at the most, and the child is given fairly complete freedom of voluntary movement, the joint being controlled for only a short time thereafter by a lightly-applied bandage which, to a moderate degree, serves to control and prevent premature indulgence in too free movement.

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As bearing out what I have said regarding the lack of interference with normal processes of growth, where this accurate replacement and fixation of fragments are carried out, I could show quite a number of examples where X-ray evidence was obtained months, and even years after, that the processes of growth were proceeding on normal lines and with normal activity. One illustrative example will suffice. Fig. 29 is a radiogram from the same case as is illustrated in Figs. 27 (A and B). This radiogram was taken a year and a half after the whole lower "capitellar" humeral epiphysis, in a boy of seven years, had been treated by open operation and direct fixation. It will be seen that both epiphyseal and diaphyseal growth had proceeded normally, and, incidentally, it will be observed that the pin, introduced through the epiphyseal fragment obliquely upwards into the diaphysis, would seem to have been carried to a considerable distance upwards within the extending diaphysis. Position and alignment were satisfactory, and functional restoration of joint movement was perfect. The boy had perfect use of his elbow, and full range of movement.

Direct Fixation in Certain Fractures of Phalanges, Metacarpals and Metatarsals.—In my former paper, in 1922, I described a method of axial fixation in certain cases of fracture of the phalanges and metacarpals which occasionally might be found useful. I gave a number of illustrative examples. The same method in similar circumstances would be applicable in the case of certain fractures of the metatarsals. Three cases are included in the second five years' series in which we made use of this method of axial fixation, two of these being fractures of the metacarpal, and one a fracture of a phalanx.

Fig. 29.—Radiogram taken a year and a half subsequent to the pinning of the capitellar epiphyseal fragment illustrated in Fig. 27. To show how epiphyseal and diaphyseal growth have proceeded normally. Note how the bone has been carried a considerable distance upwards, buried in the bone.

It is probable that most simple fractures of the phalanges will continue to be treated without open operative means, and even in the case of compound fractures, direct fixation of the fragments is not likely to be required with any frequency. There will be, however, the occasional case, perhaps somewhat neglected in the early period following the reception of the injury, in which the tilting of fragments is not readily corrected without open operation, and in which the maintenance of the correction is difficult unless some means of direct fixation is employed. We have found further, on several occasions, that a single X-ray picture has given an altogether erroneous impression of the actual position of the fragments, and even a considerable palmar displacement of one of these fragments has been liable

to be overlooked though it was mainly responsible for annulment or limitation of function. The serious disability consequent upon this displacement of sharply tilted fragments, interfering with the action of flexor tendons, has only to be mentioned to suggest the desirability of operative correction, and of the adoption of some effective means of preventing redisplacement. It is particularly desirable that operative fixation of this nature should be employed in those fractures of metacarpals or metatarsals where the bone is broken close to an extremity, for by no non-operative method is it possible to secure adequate control of the often very short articular fragment.

The procedure is simple and is easily applied. The fracture area is exposed through a short lateral incision slightly towards the dorsal aspect of the finger. The extensor tendon is drawn carefully out of the way, the fragments are disengaged, their ends are freshened, and re-alignment is established. This re-alignment is maintained by the introduction of a single fine "sprig" introduced axially from one fragment to the other, along the central canal or soft central bone, the length of the sprig employed being usually about two-thirds of the length of the broken phalanx, metacarpal or metatarsal. The head of the sprig we have sometimes nipped off with bone forceps. In other cases the sprig has been introduced from shorter fragment to longer fragment, and the head of the sprig has been left buried in the substance of the smaller fragment. It is remarkable how easy is the whole procedure, and how effective is the adjustment. The wound is closed without drainage. As I said in my former communication, "a simple (external) splint may or may not be used, according as the operator has confidence in the fixation which he has achieved, or not." In any case, the use of such an external splint should be dispensed with as soon as possible.

In the cases in which we have employed this method of axial stabilization the results have all been satisfactory. Bony union has been good, alignment has been well maintained, there has been little or no subsequent deformity, and we have been able to obtain a satisfactory functional result. Several cases in which this method has been employed are illustrated in Figs. 30 (A and B); 31 (A and B); and 32 (A and B).

Asepsis Presumed.—At this stage in the history of modern surgery it seems hardly necessary to discuss the question of the operative treatment of fractures, as if its adoption or not were to be determined by the possibility or otherwise of the avoidance of wound infection.

It is of course obvious that the surgeon who is unable to-day to guarantee, almost beyond a peradventure, the achievement of aseptic healing of the wound he must make in the operative treatment of a fractured bone, has no title to carry out such operations. But equally he has no title to perform any surgical operation for it is no more difficult to attain aseptic healing after a bone operation than after any other type of operation.

The same bogey of possible septic infection used frequently to be advanced in respect of operations upon the larger joints, and it was quite frequently maintained that it was difficult to ensure the avoidance of wound

A　　　　　　　　　　　　　　　B

Fig. 30.—Fracture of digital phalanx in an adult male, with gross displacement and mal-union. The finger was practically useless.

Open operation. Replacement of fragments, and fixation by axial implantation of a fine "sprig." (Full recovery of function.) (A) Showing the gross displacement; (B) Showing the axially implanted "sprig."

A　　　　　　　　　　　　　　　B

Fig. 31.—Mal-united fracture of proximal digital phalanx in an adult. Treated by open operation, replacement of fragments, and fixation by axial implantation of a fine "sprig." (A) Showing the gross lateral displacement, and also marked tilting of the proximal fragment towards the flexor surface; (B) After replacement, showing the axially implanted "sprig."

infection in these; it was said that there was little or no "margin of safety" in the case of one of the larger joints. Such an idea has surely gone by the board long ago.

It ought to have gone by the board also in respect of the operative treatment of fractures. One ought, by this time, to have reached the position when the possibility of any untoward happening of a septic nature should be practically impossible. Asepsis should be assumed, not merely as the desirable end to be achieved, but as the only possible result in the hands of the modern surgeon.

A Detail of Practical Importance in the Preliminary Treatment.—If one assumes that, in the carrying out of any open operation upon a fractured bone, the same aseptic surgical ritual shall be observed by the operator, and by all those concerned, as would be observed in the case of any other aseptic surgical operation, one ought to be able to rule out absolutely any possibility

A   B
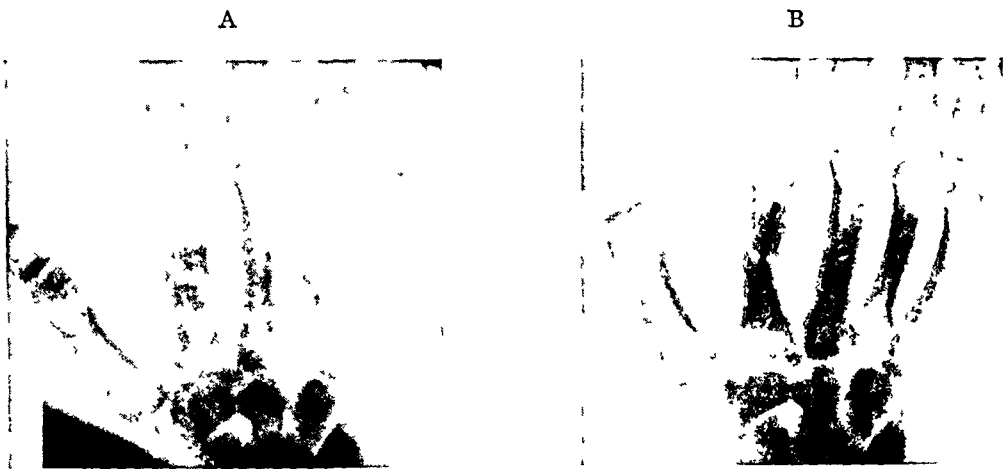
FIG. 32.—Transverse fracture of metacarpal of forefinger, fixed by axially implanted "sprig." (A) Showing the fracture; (B) The same, with the "sprig" in position.

of infection of the wound, and of the bone fragments through the ordinary channels of septic spread.

There is, however, one practical point or detail which I regard as so important that I must refer to it briefly. There is no doubt that the most potent factor in determining wound infection is the bacterial content of the skin of the area involved. Special care should be taken, therefore, to disinfect the whole area as thoroughly as is possible. But this disinfection should not be delayed until the time when operation has been determined upon. This may not be for some time after the reception of the injury, and it will be then too late. The proper time for this to be done is immediately after the patient is brought to hospital, and at as early a moment as possible after the reception of the injury. Most of us have seen the extensive irritation and vesication which may result, within even a few hours, and over a wide area of skin in the region of the damaged bone. Unless disinfection of the skin has been carried out right away there is a considerable risk of the vesicles becoming infected and even actively suppurating. The result may be the setting up of such an extensive infective process, and involving such

a wide area of skin, that a cutting operation through this area is either negatived altogether, or must perforce be delayed for some time, in the hope of getting rid of the superficial local infection.

It has been for many years now a routine procedure—an order of the day —in my surgical wards, that every case of fracture, whether simple or compound, shall be regarded as a possible case of open operation, and the first thing which must be done—it takes precedence even of X-ray examination, or the application of even a temporary splint—is the thorough disinfection of the whole area of the limb involved. By this means we feel that we are able so to assure the avoidance of any gross local infection of the skin that even should extensive devitalisation of the skin have occurred, or extensive vesication should take place, one can guarantee the avoidance locally of any gross infective disturbance, and there need be imposed, therefore, no check to the adoption of open operation at any stage when it may seem to be desirable.

When a case of fracture is admitted to my wards then, one of the first things which is done is to shave the limb over a wide area, including, and passing far beyond, the site of fracture. The whole limb is then thoroughly scrubbed with soap and water. The surface is gone over very thoroughly with spirit, and thereafter with an antiseptic lotion—generally 1-40 or even 1-20 carbolic. It is then thoroughly dried with sterile towels, and is wrapped carefully in several layers of sterile gauze. We have then no further fear of skin infection. Even should extensive vesication occur these vesicles remain aseptic, their fluid content remains clear, and they may be allowed to shrivel up by natural means, or they may be punctured if it seems desirable. But the practical point is that at any moment from the time when the patient is admitted, the surgeon may, if he choose, carry out an open operation through that disinfected skin without fear of any local infection. I would recommend the adoption of such a method as routine procedure in any casualty ward, even if the surgeon in charge is not a believer in the open operative treatment of fractures. He will avoid thereby any of those troublesome inflammatory conditions of the skin which otherwise may readily occur, and the occurrence of which, in former times, when such steps were not taken, probably determined the development of erysipelas and other local infections which complicated, and often gravely aggravated, cases even of simple fracture.

Two Cases of Serious Infection in the Combined Ten Years' Series.—It would be untrue to say—even as it would be insincere and wanting in frankness were I to allow the impression to be conveyed—that on no occasion has sepsis complicated any of our cases. But throughout the whole combined series of ten years, and through the nine years previous, there have been only two cases in which anything beyond the most trifling infection has occurred.

In one of these we lost the patient. He was an elderly man who had an extremely severe fracture of the upper end of the shaft of the femur, involv-

ing not only the upper third of the shaft, but separating, at the same time, both trochanters and splitting the femoral neck. The whole area was badly comminuted, and the fragments were widely displaced. The man's general condition was not good. He had been in poor health previously, and active operative interference was decided upon not without misgiving; but it was thought that the adoption of direct fixation might permit us to give him, at an earlier period than we could otherwise do, a certain degree of freedom which we feared to do otherwise. We had the hope that it would enable us to let him sit up in bed, and even to get out of bed at an ealier period. The operation was difficult but was successfully carried through, and the operation was well borne. For a time all went well, but a good deal of blood accumulated and a mild infective process occurred which in spite of treatment, led ultimately to his death.

The other case was that of a youth who had a severe spiral fracture of the femur about its middle. It was almost compound and there was some comminution. In the course of the operation one considerable smaller fragment became disengaged, was accidentally projected from the wound and slid across the floor of the theatre. As it was a somewhat essential fragment, I had it picked up from the floor, I scrubbed it well with a nail-brush in an antiseptic solution, and reintroduced it in its proper setting before plating the main fragments. The wound was entirely closed, and the patient pursued a normal course for six weeks when, for the first time, the wound was dressed. It appeared to be quite healed, and the limb was in excellent alignment. The sutures were removed and everything seemed satisfactory. A few weeks afterwards, however, a small fluctuant swelling appeared from which there was evacuated a quantity of disintegrated blood-clot, and subsequently the small bone fragment which was completely necrosed, had to be removed. There was in this case thereafter, and for some considerable time, a mild degree of infection which considerably lengthened not only the period of convalescence, but also the achievement of satisfactory bony union. Fortunately in the end the result was quite good, and the patient was left with a useful limb.

These two cases then may be taken as representing practically our only experience of ill-results from septic complications, and I suggest that we are entitled to regard them not as warnings against the frequent employment of open operation and direct fixation, but rather as reminders merely of the necessity for the rigid observance of the ritual of any surgical operation; as, in fact, exceptions that prove the rule. I have no doubt now that I should not have risked the replacement of the small fragment which became disengaged in the second case, and that the untoward result was really the result of an error of judgment on my part. It would have been much better to leave the fragment out altogether and trust to nature to make good the defect in her own way.

CONCLUSIONS

A critical consideration of the cases and results in the two periods of five years, and of the similar cases and results in the previous nine years, as well as our more recent impressions in the three years which have elapsed since the end of the second five years' period—i.e., *a consideration of an experience extending now over twenty years*—leads me to the formulation of a number of conclusions which I may now state very shortly.

First: Open operation, and the adoption of some form of direct fixation are not merely justified in a certain number of unusual fractures, or in a certain number of fractures with unusual displacement, but are justified in a substantial proportion of fractures of the long bones almost as a routine procedure. In certain bones, indeed, it is the surgical procedure not merely of choice, but of necessity.

Second: Open operation and direct fixation ought to be possible, and are possible, in any surgical clinic worthy of the name, and there should hardly even be the fear of possible occasional septic infection. We ought to be able to assure aseptic healing of a fracture dealt with by open operation with as great certainty as we can assure it in any surgical procedure.

Third: In the case of fractures, or fracture-separations, in the region of the elbow where there is any appreciable displacement, open operation and direct fixation afford the most favorable conditions for the early restoration of function, and for the normal continuance of growth at the epiphyseal line.

Fourth: We have not found that by the adoption of open operation and direct fixation, there has been induced any diminution in the activity and efficiency of the processes of repair. Union has not been, in our experience, in any way retarded, but rather the reverse. In our whole experience, I know of only one case in which union was substantially delayed, and of no case in which union absolutely failed. I find it difficult to understand the reports of those whose experience would seem to have been different from ours in this respect.

Fifth: There is no doubt at all that in the large majority of cases dealt with by open operation, and in which the fragments are fixed by some internal mechanical means, the period of confinement to bed—the period of hospitalization—ought to be, and is, very substantially shortened. Personally, I know that if I had to deal with two precisely similar fractures of the femur, the one dealt with without open operation and the other treated by plating, that when the stage had been reached where in both cases union might be expected to be established, I should with infinitely greater confidence allow the patient with the plated femur to get about freely. I should feel that the repair of the bone in this case, reinforced still further by the plate, justified one in permitting a degree of liberty in the use of the limb which one might hesitate to permit at such an early period in the other case; and it is clear that, the earlier such liberty can be given, the shorter will be the period

during which the muscles are left to atrophy, and the sooner may one look for effective restoration of function.

Sixth: With increasing experience I become progressively more and more convinced that correct anatomical reposition and re-alignment are the most important factors of all in the promotion of normal functional restoration. Not all the writings and teachings of the manipulative school will convince me, either that by the adoption at too early a period of massage and movement will you obtain in the end, on the average, a better functional result than in the case where operative means are taken to restore a continuity approaching as nearly as possible to perfect anatomical restoration; or, on the other hand, that we should accept the position that function alone matters, and that we need concern ourselves not at all with displacement or deformity.

Seventh: We have passed far beyond the position where open operation *may perhaps* be adopted in special cases where some unusual difficulty may seem to have occurred. We have reached the position now when it is not so often necessary to justify the choice of an open operative procedure, as to justify or explain away the failure to adopt it. I am convinced now that, by the adoption of open operation and direct fixation, I am able to offer to the patient a much surer and speedier restoration to his normal activity.

. It may be not without interest in this connection if I refer to an inquiry I had in 1923 from your own brilliant exponent of the surgery of fractures, Dr. Charles L. Scudder—one of the first authorities of the day on the subject—in which, referring to my paper delivered before the British Medical Association in 1922, he expressed the wish that I might record the functional results in my cases, and the exact time the patients were away from their employment as the result of their injuries. He went on to ask the following striking question, which at first surprised me a good deal: "Have you *any* fractures of the femur back at the same job as before the accident? —treated either by operation or not?"

I may say that, following the reception of this inquiry, I made a careful investigation into our results in these cases, and I am happy to say that we have had much better results than the putting of such a question would seem to lead one to expect. As a matter of fact, more than half of our recorded cases of fracture of the femur have been able to resume their former, or similar, work; in some cases involving such exercises as climbing ladders.*

It may also be not without interest to mention that, a year or two ago, when Dr. Scudder honored me by visiting my clinic in Glasgow, and seeing there not a group of carefully selected cases, but cases in the ordinary routine of treatment and "follow-up" observation, I was able to show him a number of cases, not specially selected, which I think must have convinced him of the satisfactory and early recovery of function for which we are accustomed to look. I remember particularly one case of fracture of the femur operated on only about three months before, which Dr. Scudder himself put through

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* This estimate does not apply merely to fractures of the shaft of the femur, but includes all fractures of that bone—neck and upper end, shaft and lower end. (A. Y.)

a very elaborate series of movements and tests, and in which I think he altogether failed to demonstrate any appreciable functional defect.

Eighth: The experience of these twenty years during which I have been led, in a substantial number of cases, to adopt an open operative procedure .in the treatment of many fractures of the long bones, has increasingly established my confidence in the method, not only as being safe in its execution, but as affording the most hopeful outlook in respect of the early recovery of function, and the most perfect restoration of the anatomical normal.

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DISCUSSION.—DR. ASTLEY P. C. ASHHURST (Philadelphia): asked Professor Young if he could tell them what was the total number of fractures on which his operative figures were based. It makes a great difference whether one starts one's percentages with all the patients in the out-patient service as well as those in the wards, or only with the patients in the wards.

Among 5000 admissions to Dr. Ashhurst's service, Episcopal Hospital, there were 492 recent fractures (9.8 per cent. of total). Among 492 recent fractures there were 46 operations (9.2 per cent.).

Region	Admissions	No operation	Operations
Head and face	55	53	2
Vertebræ and pelvis	18	17	1
Clavicle	11	10	1
Scapula	2	2	0
Ribs	21	21	0
Humerus	29	27	2
Elbow	13	5	8
Forearm	22	15	7
Wrist and hand	31	22	9
Femur	76	72	4
Patella	9	5	4
Leg bones	102	100	2
Ankle	74	72	2
Foot	29	25	4
Total	492	446	46

He had gone over recently the last five thousand admissions to his service at the Episcopal Hospital. That includes all the ward patients, and a certain

number of out-patients who are sent in because they are severe fractures, or apparently irreducible. He finds that of the five thousand admissions, less than 10 per cent. were fractures, so that his experience with fractures is relatively small. Among 492 *recent* fractures (that is only the *simple* fractures, *compound* fractures and recent *simple* fractures without malunion or non-union) there were less than 10 per cent. of operations. In tabulating the regions, in the femur, he had had, among these 5,000 admissions, seventy-six patients with fractures of the femur, among whom four seemed to him to require operation. He had had 102 patients with fractures of the leg bones, among whom two seemed to require operation.

He had no objection to operation. His only object in treating fractures was to get good results.

Table II was made up seven years ago, up to May 1, 1923. He had then done 148 operations for fractures of all kinds, of which 42 per cent. were for simple fractures (i.e., *recent* simple fractures); 11 per cent. were on compound fractures; 33 per cent. were for malunion, and 14 per cent. for non-union. These cases of malunion and non-union, with *very* few exceptions, came in with the condition and were not the result of his care.

Operations for Fractures (to May 1, 1923)

Operation	Simple	Compound	Malunion	Non-union	Total
Plate	15	7	6	3	31
Screws	25	0	10	4	39
Cerclage	2	2	1	0	5
Suture, chromic	10	1	0	1	12
Suture, wire	0	0	0	1	1
Excision joint fragments	5	2	2	2	11
Tenotomy Tendo Achilles	2	0	0	0	2
Open reduction	3	4	0	0	7
Bone transplant	0	0	2	10	12
Arthroplasty, etc	0	0	11	0	11
Osteotomy	0	0	8	0	8
Non-reducing	0	0	9	0	9
	62	16	49	21	148

Since May 1, 1923, his percentage of operations for recent simple fractures had advanced from 42 per cent. to 50 per cent. of the total. That is to say, in the last seven years he had operated on 32 per cent. simple fractures. That is less than five a year. Two compound fractures had been operated on in the last seven years.

For malunion, fifteen operations, or 24 per cent. of the total; and 22 per cent. of the total operations were for non-union.

He had found that when he had used fixation material of screws or plates or wires, he had had to remove it eventually in about 16 per cent. of the cases. Unless there was some indication for removing it he had left it until the patient died of old age. There are patients going around now with the fixation still in place after fifteen or more years.

Of those that he had had to remove, about one-half were for incidental

Operations for Fracture (A.P.C.A.)
May 1, 1923 to May 1, 1930

Region	Recent Simple	Compound	Malunion	Non-union	Total
Vertebræ....................	1	0	0	2	3
Face......................	3	0	0	0	3
Clavicle...................	2	0	20	0	4
Humerus..................	2	0	0	3	5
Elbow....................	6	0	2	2	10
Forearm..................	6	0	2	3	11
Wrist and hand............	0	0	5	1	6
Femur*...................	3	0	0	0	3
Patella...................	5	0	0	2	7
Leg bones................	1	2	0	1	4
Ankle....................	0	0	4	0	4
Foot.....................	3	0	0	0	3
Total....................	32 (50%)	2 (3%)	15 (24%)	14 (22%) 63	

* No operations on *shaft* of femur since 1916.

reasons, operating on the patient again for something else and taking out the fixation material because it might in the future give some trouble. About a fifth were removed on account of pain, where it was thought that perhaps pain was caused by the fixation apparatus, and about a third were removed for persisting or developing infection. For instance, in compound fractures if one puts in fixation material against the bone, not infrequently it has to be removed to enable the wound to heal up, and in a few patients something like the following will happen: I plated a simple recent fracture of the radius and ulna in a girl about fourteen years of age; after two or three years she came back with an abscess over the site of plating following a severe tonsillitis complicated by cervical adenitis—evidently a metastatic localization in a *locus minoris resistentiæ*.

DR. WILLIAM L. ESTES (Bethlehem, Pa.): said that in the investigation of the committee on fractures for this Association it was found that in the United States and Canada the average time of disability was decidedly longer for cases of open operation than for those treated by the closed method. If his recollection held, it is about a month's difference between. One must take into consideration, that the operation was done by operators generally over America, not by half a dozen men or two or three men accustomed to doing this work, but by surgeons generally. It was a study of over two thousand cases which brought out this point.

A second point is that although open operation produced better anatomical results, the functional results were better in non-operative cases in America. The figures showed that there were 73 per cent. of cases with non-operative treatment which resulted in good functional results, whereas with the operative cases it was 76 per cent. That, remember, is also a collection of the results of all surgeons in America, that is, all who reported. With men who are accustomed to doing this work it is a different matter, and it brings one to

the point that a surgeon who is not prepared by proper technic and proper surroundings had best hesitate unless the indication is absolute for operation.

A man who has been prepared as the reader of the paper and who is accustomed to doing this operation will find that his general result will be good.

He had found, investigating his own cases, that he was operating in 38 per cent. of the cases, and he believed that that was not an exaggeration in the clinics of men who are prepared to do this work. He again reiterated that while proper technic and proper preparation would result in much better results and much shorter disability than in the non-operative cases, in the generality of cases, with all surgeons, the result was the opposite.

Doctor Young, in closing, said: "The statistical argument, from the point of view of the duration of the period of incapacity, is a very difficult one to meet, because, as he had indicated, the figures from one clinic may differ very widely from the figures of another. He had given his own figures. So far as he had been able to make them so, they were absolutely reliable."

Many of the operations upon fractures, especially upon fractures which have taken place some considerable time before, are operations which tax, to the utmost, the energy and physical powers of the operator. The labor is really very heavy. It is extremely unlikely that, as one advances in years, one should, at the same time, continue to employ the operative method—and with increasing frequency—in view of the excessive labor which is involved in it, unless one were really convinced of its value. It seemed to him that this argument is quite a good one, as bringing out one's real belief in the procedure.

As to the removal of the plate and screws, it does not appear that there is anything to be ashamed of in having to remove a plate, or in deciding to remove it, as a procedure of choice. Just as one removes an external splint, when it has served its purpose, so one may, on occasion, or as desired, remove an internal splint. There is no essential difference.

In the case of a fracture of the tibia, for example, one is dealing with a bone which is practically subcutaneous, and which, more particularly in a working man, is exposed to many a knock or blow on the shin. One takes a considerable risk if one decides to leave the plate in position after it has served its purpose. Its covering of soft tissues is very scanty, and it is very easy to understand how it may cause trouble. It is very different in the case of the femur, which has an abundant muscular covering to protect it from direct injury, so we very commonly remove the plate and screws in the case of a fracture of the tibia, but very seldom in the case of the femur. He knew of only one case of non-union, or of considerably delayed union, in the whole of his experience. He failed altogether, therefore, to understand how the numerous cases of non-union or of delayed union, which are reported by others, come about.

FRACTURES OF THE NECK OF THE FEMUR WITH SPECIAL REFERENCE TO THE TREATMENT OF INTRACAPSULAR FRACTURE

By Hugh McKenna, M.D.

of Chicago, Ill.

Foreword.—In presenting some phases of the treatment of intracapsular fractures of the neck of the femur, I wish to state my position before proceeding with this paper.

At present the methods giving even relatively good results seem to remain rather individual and therefore somewhat restricted in general application. Consequently, the general statistics on end-results of treatment of these fractures do not appear to have been greatly improved and therefore do not compare favorably with the results following the treatment of extracapsular fractures. For this reason the presentation of evidence pertaining to any method that may lead to a higher degree of efficiency in treatment should be acceptable. Until a standard method of procedure, giving generally a higher percentage of good end-results, is developed, the various special methods may be followed to advantage.

With these ideas in mind and without committing myself to the position of advocating the open method in any but carefully selected patients, based particularly on age and physical condition, I desire to submit some facts that I believe are of importance in the treatment of these fractures, both by the closed and open methods. I wish especially to draw attention to the following points:

1. The nutrition of the head and neck of the femur.

2. Some recent investigations of Leriche and Policard pertaining to the function of autogenous bone transplants that seem to prove scientifically their value in the production of callous formation in slow-healing fractures, thereby giving a logical reason for utilizing transplants in the treatment of some intracapsular fractures.

3. The value of the principle of impaction.

Any extensive review of medical literature pertaining to the treatment of fractures of the neck of the femur reveals a wide discrepancy in the end-results. It would appear that this discrepancy may be accounted for in part on the basis of classification, since the problem of determining whether the fracture has occurred entirely within the capsule (especially if it occurs near the attachment of the distal capsular ligament) may be impossible. In the fractures treated without operation a mistake in classification may frequently occur. In this paper the old classification of intracapsular and extracapsular is followed, not because such a division is ànatomically correct, but because clinically it appears to give a workable basis for an intelligent method of

procedure in the treatment of these fractures. The term intracapsular shall be used to designate any fracture of the neck of the femur that occurs entirely within the articular capsule or at the distal attachment of the capsular ligament, while the term extracapsular shall apply to fractures entirely outside the capsule of the hip-joint. Some authors have used the term transcervical and sub-capital instead of intracapsular to describe fractures of the neck of the femur within the capsule. The objection to this classification lies in the fact that all fractures within the capsule do not fit this description, especially those that occur near the distal attachment of the
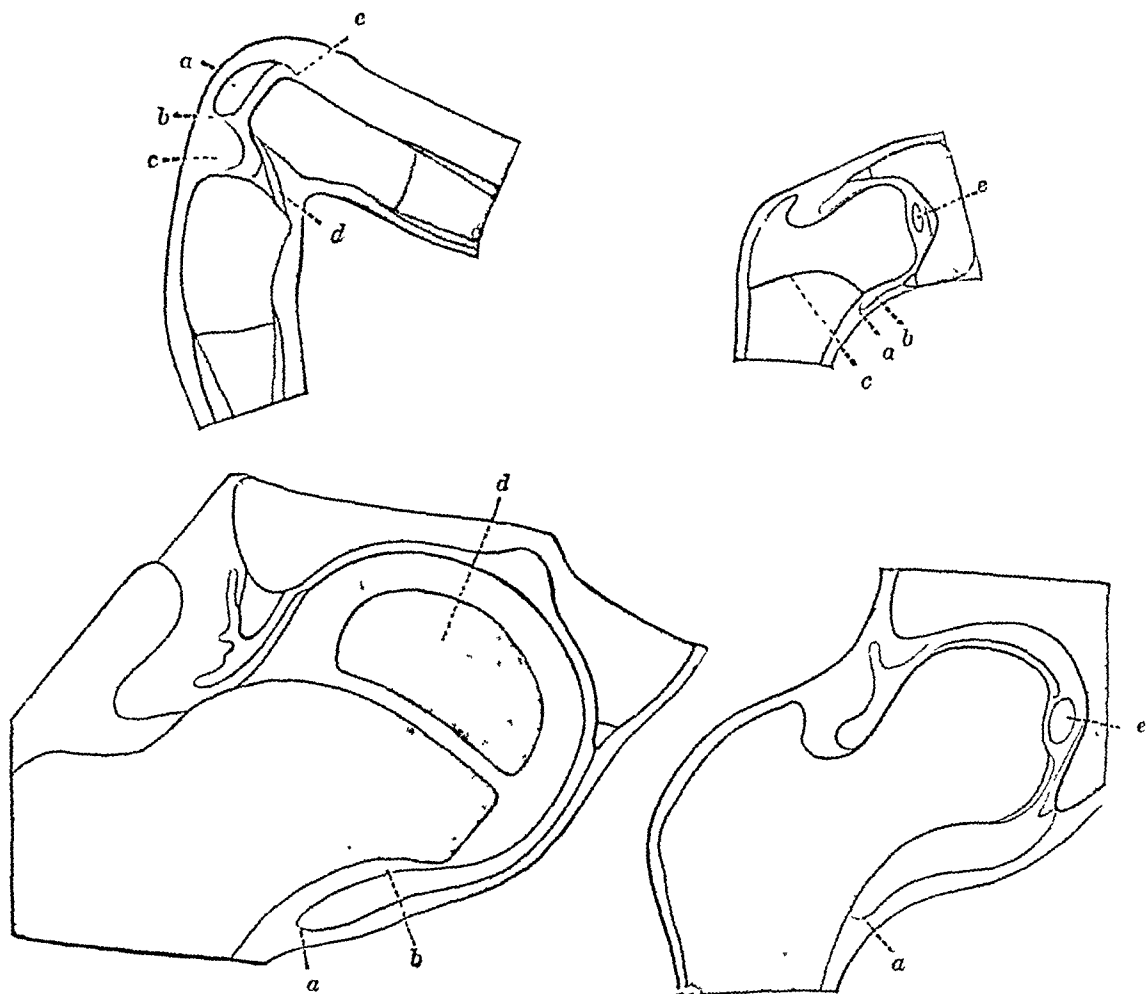
Fig. 1.—Cut taken from Keibel and Mall Embryology ("After Schulin, Aichiv of Anatomie, 1879"). Cross section of a human hip-joint in a male fetus 25 centimetres in length, a female six years of age, and an adult male.

capsular ligament. Those fractures occurring within or partly within the attachment of the distal capsular ligament are not anatomically either intra- or extracapsular fractures. However, they are subjected to much the same nutritional disturbance as the transcervical type, and may therefore be classified in the same group for the purpose of treatment.

Before proceeding to the discussion of the treatment of these fractures, I wish briefly to review some points in the embryology and anatomy of the hip-joint that have a bearing upon the nutrition of the head and neck of the femur at different stages of development.

According to Keibel and Mall (vol. i, pp. 370-371), (Fig. 1), while the

embryo is growing from twenty to thirty millimetres in length, cavity formation begins between the head of the femur and the cartilaginous plates forming the floor. At this stage a fibrous band passing through the joint cavity can be made out that is to form the ligament um teres, and, according to Moser (Uber das Ligamentum Teres des Heuftgelenks) as quoted by Zemansky and Lippman (Importance of Round Ligament Vessels, Surg., Gyn. and Obstet.), blood-vessels can be determined in

Calcar-
femorale

Lesser
trochanter

Oblique section of right femur parallel to lower border of neck, through upper end of lesser trochanter.
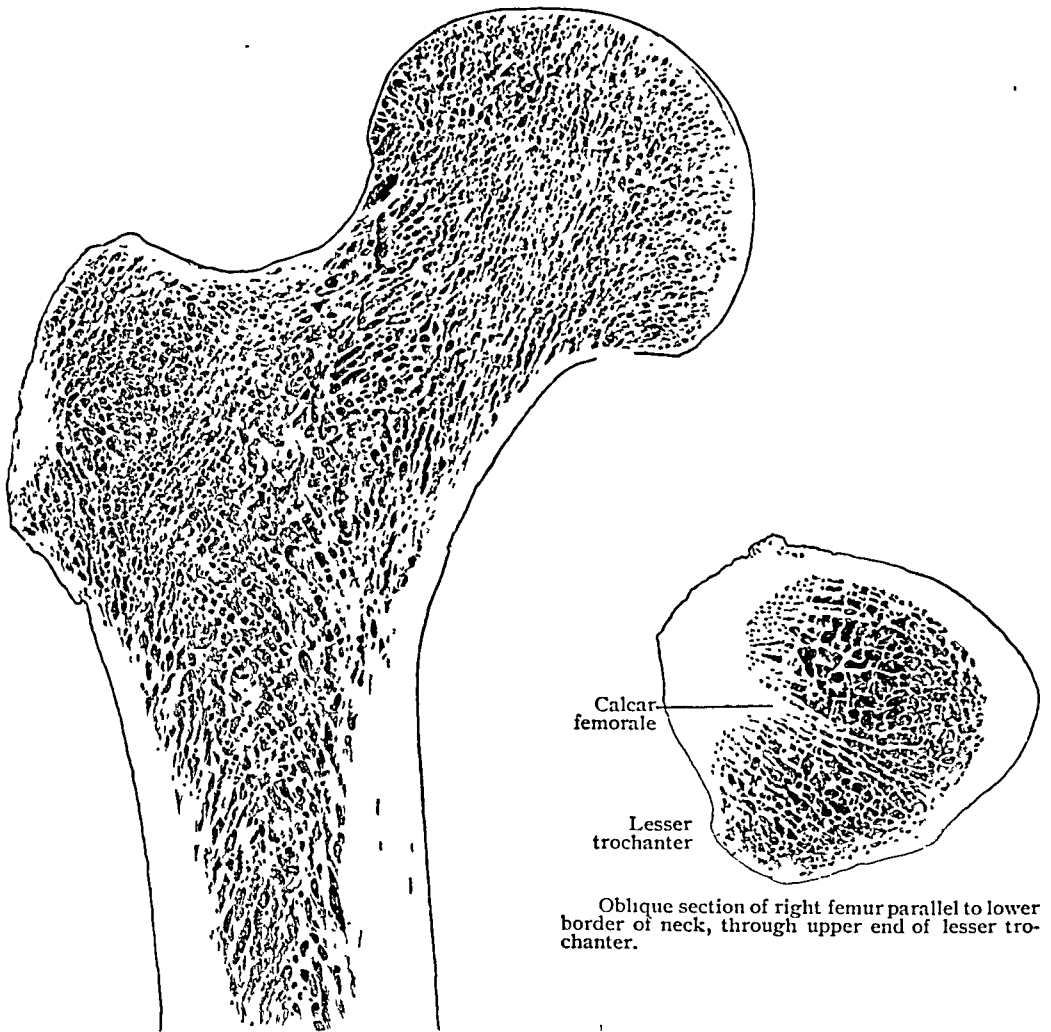
FIG. 2. Cut taken from Piersol's Anatomy showing the neck of the femur to be made up principally of spongy tissue and the trabecular arrangement in two definite systems.

this structure that persist to at least the fourth year of life. How much later these vessels accompanying the ligamentum teres function in life is a disputed question, although Moser wrote: "Later, most of these vessels unquestionably atrophy." It would seem, then, that these vessels, while of nutritional importance in fœtal life and during the first years of life, are a negative source of blood supply to the head of the femur in adult life. A. Kolodney (Blood Supply of the Head of the Femur, Jour. Bone and

Joint Surg., 1925) has given a very detailed description of the blood supply to the head of the adolescent femur under four headings:

1. Blood-vessels coming from the diaphysis of the femur,
2. Epiphyseal blood-vessels,
3. Blood-vessels accompanying the ligamentum teres,
4. Periosteal vessels.

In the event of an intracapsular fracture these vessels may be considered in the light of end arteries and it will readily be seen that all of these vessels

FIG. 3.—An impacted intracapsular fracture of the neck of the femur treated by the abduction method.

may be injured, so that whether a blood supply sufficient to nourish the head and proximal fragment of the neck of the femur remains or is reëstablished may determine whether bony callous will result.

Now to pass to a consideration of the inner architecture of the head and neck of the femur as demonstrated in the accompanying picture (Fig. 2), note that the neck is made up almost entirely of spongy bone tissue which consists of two definite systems of trabeculæ, with one system beginning on the mesial side and the other coming from the lateral side of the upper end of the shaft of the femur intersecting each other at right angles. The neck of the femur is made up almost entirely of spongy tissue arranged in the

manner described, so that Koch (Laws of Bone Architecture, Am. J. Anat., vol. xxi, p. 1917) has given a mathematical analysis of the theory advanced by Wolff and Roux to the end that the anatomical arrangement is such that the minimum of material used in the inner architecture of the femur gives a maximum of strength.

This discussion of the treatment of intracapsular fractures is based upon embryological and anatomical facts that show a reason for the assumption that a nutritional disturbance in the fragments takes place in these fractures as a result of a disturbed blood supply. Fractures elsewhere in the body are not influenced by nutritional disturbances to the same degree. Professor Ernst W. Hey-Groves says, "fractures of the transcervical or intracapsular variety are of quite common occurrence in young or middle-aged patients; such fractures will never unite unless natural or artificially induced impaction of the fragments is produced." Professor Hey-Groves has reported bony union in a small series of these fractures treated in the recent state by the use of bone transplants. This procedure brings up the question whether to treat these fractures, in patients who are good surgical risks, by open operation immediately or to postpone the operation pending the development of non-union. From the standpoint of results, the ideal time to perform the bone transplant operation is from six to ten days following the fracture, before any absorption has taken place in the spongy tissue in the neck of the femur and the fragments can be brought into accurate alignment. After a number of months have elapsed following fracture and non-union is discovered, as a rule some absorption of the fragments has taken place, and while the introduction of a bone transplant at this date may give bony union, the reconstruction of the neck of the femur usually leaves some shortening and consequent deformity.

A résumé of the end-results of the most experienced surgeons who have treated these fractures by the closed method, where impaction has not occurred, demonstrates that bony union does not compare favorably with the end-results in the extracapsular type of fracture, where there has been a much lesser disturbance in the blood supply. These findings are in keeping with the researches of Leriche and Policard (Physiology of Bone) who have shown that in fractures without hæmorrhage and blood-clot, non-union as a rule follows. In my own experience in the open treatment of intracapsular fractures where the capsule was opened, no appreciable amount of hæmorrhage or blood-clot was noted, either in the joint or at the site of the fracture.

In my opinion, the ideal procedure in the treatment of these fractures is the abduction method following impaction either naturally or artificially produced. Cotton, of Boston, has produced artificial impaction in intracapsular fractures and I have observed some of his splendid results. Whitman reports a high percentage of bony union by the abduction method of treatment whether impaction is present or not. However, when one views the end-results obtained in these fractures where conventional methods have

FIG. 4.—An intracapsular fracture before reduction.
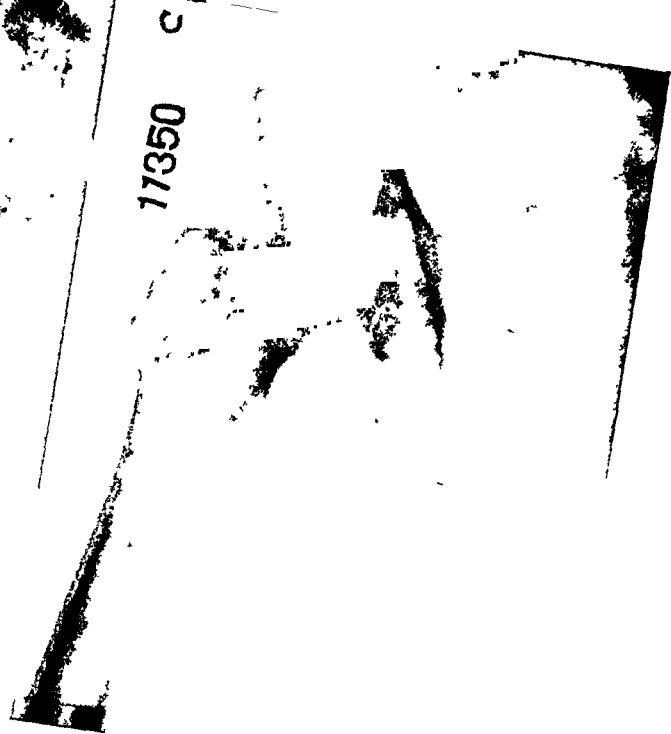
FIG. 4A.—Treated by means of an autogenous bone transplant. Picture recently taken. Patient now at hospital (August 8, 1930).

FIG. 5.—Interthrochanteric fracture before reduction.

FIG. 5A.—After reduction by the abduction method.

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FIG. 6.—An intracapsular fracture before reduction.
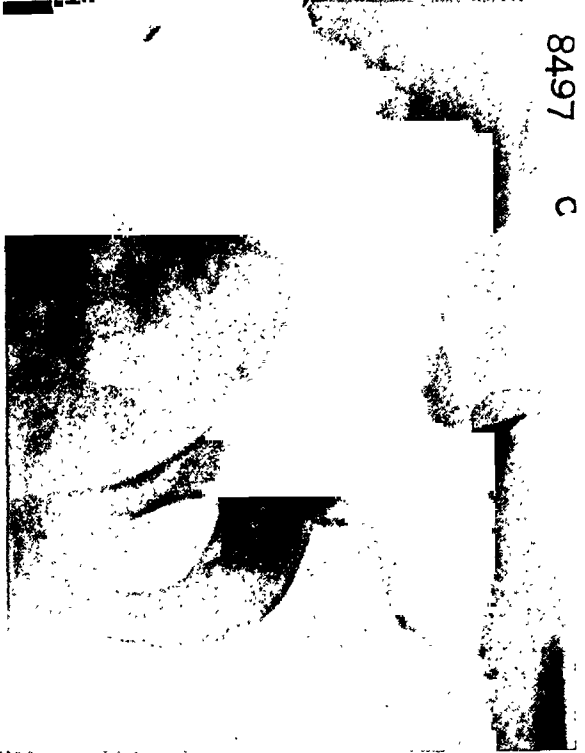
FIG. 6A.—A picture over a year following treatment by the abduction method.

FIG. 7.—An intracapsular fracture of the neck of the femur reporting for treatment over two months following injury.

FIG. 7A.—Same patient showing an end-result treated by an autogenous bone transplant introduced without opening the capsule.
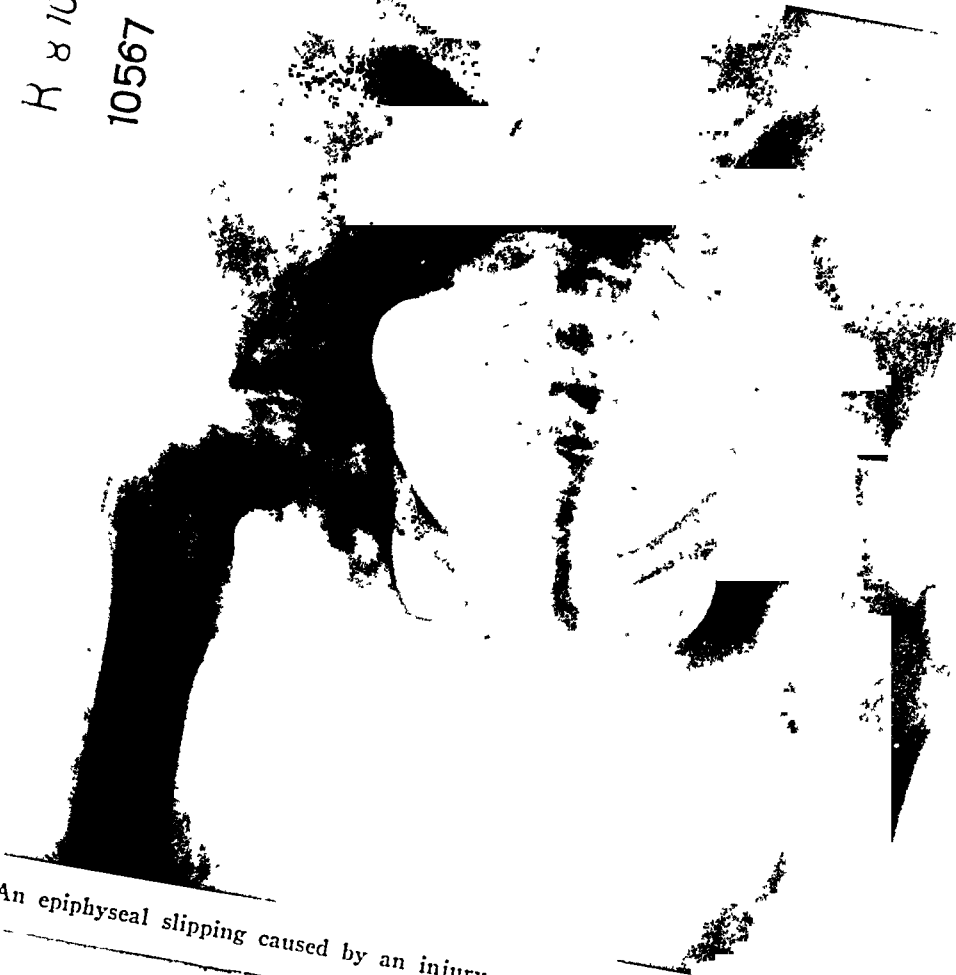
FIG. 8.—An epiphyseal slipping caused by an injury and reporting about nine months after accident.

FIG. 8A.—Same, patient treated by abduction and some traction.

been followed, the percentage healing by bony union is too small to allow one to be content to follow any one method that has been outlined.

With these results in mind I began, about fifteen years ago, to treat a small number of intracapsular fractures of the neck of the femur by the open method. I selected a number of patients suffering with this type of fracture whom I considered good surgical risks. There have been only twenty operations performed on nineteen patients, but owing to a very careful selection of the physical condition of the patients, no deaths occurred and no infection followed the operation.

Mention is made of these facts because, in departing from conventional methods of treatment to a more radical line of procedure, I believe the

FIG. 9 —An end-result in the treatment of an intracapsular fracture by an autogenous bone transplant

FIG. 10.—An end result in an intracapsular fracture treated with an autogenous bone transplant.

surgeon should assure himself as nearly as possible that the course followed, although it may give a higher degree of assurance that a better result may be obtained, is not subjecting the patient to an unnecessary risk. In all but two operations an autogenous bone transplant was utilized to secure the fragments and was taken from the crest of the tibia. While I realize that a discussion of the function of bone transplants, in the treatment of any special type of fracture, will hold equally in considering the treatment of every fracture where its use is indicated, I wish to review some findings respecting the autogenous bone transplant that is of special importance in the treatment of intracapsular fracture.

Leriche and Policard (Physiology of Bone, Authorized English Translation by Moore and Key) are of the opinion that most surgeons hold an erroneous view respecting

the rôle of the bone transplant. They conclude that the operation of removing the transplant immediately produces its death, but, being a tissue of low vitality, does not undergo rapid change. According to these investigators, the important function of the transplant consists in furnishing calcium in the process of ossification in callous formation. Their researches respecting calcium and phosphorus metabolism are too detailed for inclusion in this paper.

Barth (quoted by Leriche and Policard) decalcified the transplant and produced only a fibrous union. Leriche and Policard further have demonstrated the manner in which the bone transplant changes in its new environment. Following the blood-clot embryonal connective tissue is formed at either end and along the lateral surfaces of the transplant. At the same time, similar changes have taken place within the transplant and new connective tissue is growing into the Haversian cana's. During this period rarefaction is taking place in the fractured ends of the bone, a change that appears to result as calcium is furnished to the embryonic connective tissue in the process of ossification. Consideration of the histogenesis of the bone tissue forming the callous seems to indicate that the autogenous bone transplant should be the material of choice in the repair of these fractures where treatment is carried out by the open method.

The method followed in the treatment of these fractures must depend upon a number of factors: first, the age and physical condition of the patient; second, whether the fracture is impacted or the position shown by the X-ray is such that the fragment may be brought into good alignment; and finally, if the open method is adopted in the indicated cases special equipment is advisable and carefully controlled surgical technic is imperative.

If careful X-ray examinations are made of fractures of the neck of the femur, I am of the opinion and it has been my experience that the surgeon may determine in advance whether it is necessary to open the joint capsule in introducing the bone transplant. I have performed the operation without opening the capsule and have secured as equally good results as when the capsule was opened. I have succeeded without opening the capsule while introducing the transplant, in securing bony union in an intracapsular fracture, that had occurred over two months previously. It may be that bony union may be obtained with this plan in much older cases. I wish to call attention to the plan of introducing the bone transplant without opening the capsule as it is a much simpler and safer operation.

The L-shaped incision I have used begins at a point just below and external to the anterior inferior spine and passes back over the great trochanter and then down the outer side of the thigh. As shown in the accompanying diagram, approach to the hip-joint is made without encountering important structures. The dissection is carried down to the intertrochanteric line and just proximal to it the anterior capsule is exposed and may be opened if the surgeon deems such a step advisable.

I desire to call special attention to certain points in the technic of the operation: A dowel opening is made through the compact portion of the shaft of the femur by means of an electrically driven drill and the opening is continued through the neck into the head by means of a hand drill, in order to minimize the amount of injury to the spongy tissues of the neck. The hand drill gives a better sense of direction in approach to the proximal
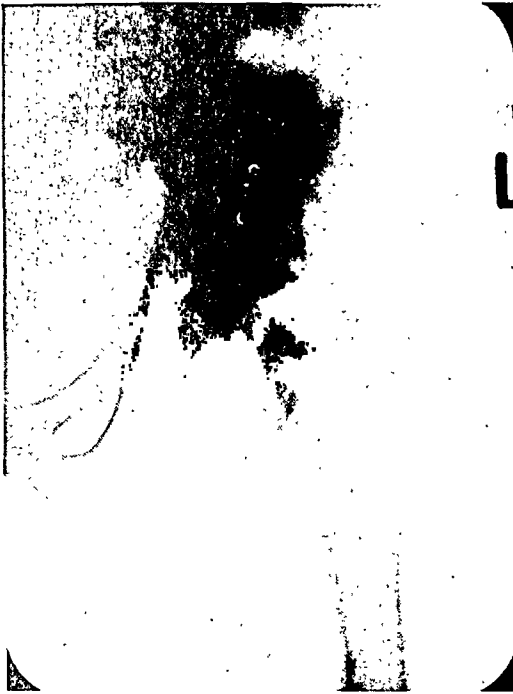
FIG. 11.—Intracapsular fracture treated with an autogenous bone transplant.
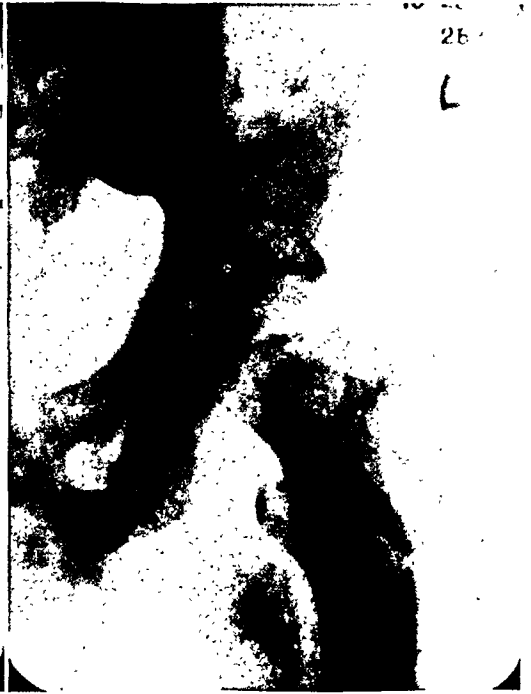
FIG. 12.—An intracapsular fracture treated with an autogenous bone transplant.

FIG. 13.—An intracapsular fracture approximately six weeks old.
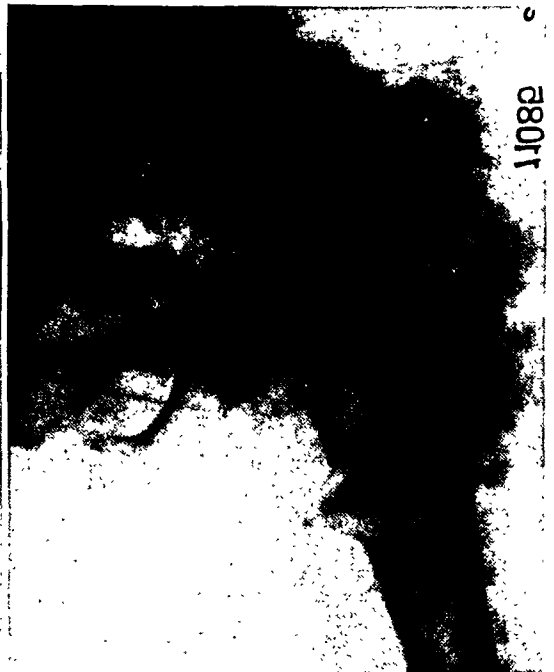
FIG. 13A.—Same, treated by means of an autogenous bone transplant without opening the capsule.

fragment and head of the femur. The only type of bone transplant used has been from the patient's tibia and contained the periosteum. The transplant has been removed with a minimum of trauma and driven into the previously prepared dowel opening in the neck of the femur. I have placed
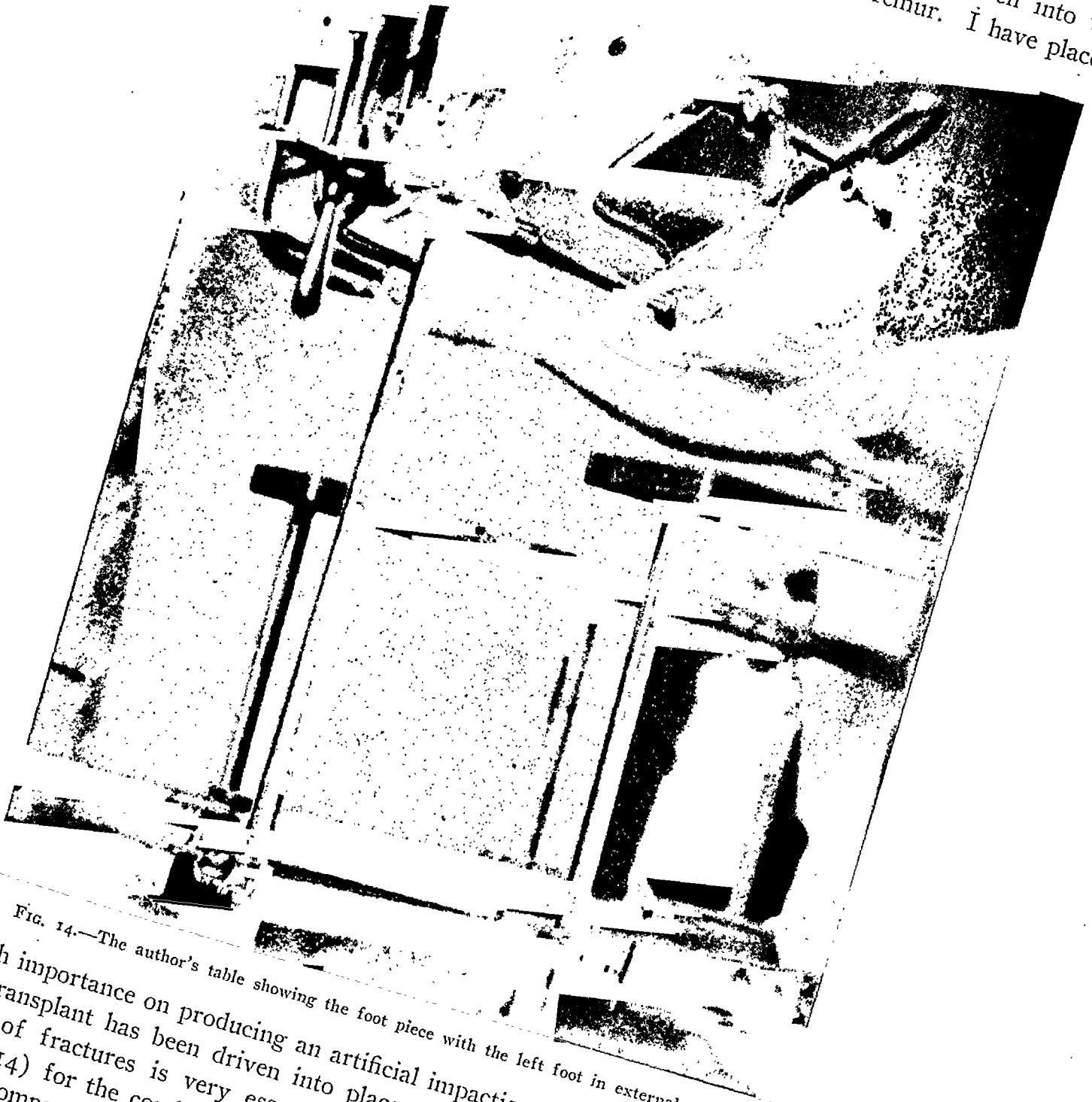
FIG. 14.—The author's table showing the foot piece with the left foot in external rotation.

much importance on producing an artificial impaction of the fragments after the transplant has been driven into place. Special equipment in the treatment of fractures is very essential. I have worked out a special table (Fig. 14) for the conduct of this work, a late model of which is shown in the accompanying picture, with a special heel piece and adjustable foot

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attachment; internal and external rotation can be accurately controlled. This I believe to be one of the very important factors in the successful treatment of these fractures.

In reviewing the operations performed in this series, I have the following comments to make:

In the first two operations steel nails were used to secure the bony fragments. In the remainder autogenous tibial bone transplants were utilized. One patient developed a pulmonary embolism in the third week following operation, but after a somewhat stormy convalescence recovered. A second patient had a limitation of motion in the knee of the affected side, not being able to flex the knee only slightly over ninety degrees, although in the repair of this fracture one of the best anatomical results was obtained. In the first two operations, where steel nails were used, non-union resulted in both instances. In one of the fractures treated in a recent state with the fragments held in excellent position by means of a tibial bone graft, non-union resulted. In a tuberculous patient treated for late non-union, the operation being performed twice about a year apart, only fibrous union resulted.

Owing to my inability to reach some of the remaining patients following discharge from the hospital at the end of four months, it is impossible to record the final results in all of them. Then, too, the number was too small to give very conclusive information. However, this paper was written to show the following points in the treatment of intracapsular fractures of the neck of the femur:

1. The open method of treatment may be carried out in carefully selected patients without undue risk.

2. Some fractures may be treated without opening the capsule, thereby simplifying the operation.

3. The physiology of bone repair seems to show that the autogenous bone transplant accelerates callous formation in fractures with poor blood supply and therefore may be used to advantage in the repair of certain intracapsular fractures of the neck of the femur.

DISCUSSION.—DOCTOR KELLOGG SPEED (Chicago) remarked that the important thing in fractures of the neck of the femur is the mortality and the uncertainty of the result in those that survive. One never knows whether the bony union is lasting or whether the head is going to necrose and die later on. There are three points in connection with the treatment: first, the blood supply of which the essayist spoke; second, the position of reduction of the fracture; and third, the bony union which is acquired which must be supported by a brace until the vitality of the head is assured. The blood supply in the head and neck of the femur comes from the ligamentum teres, from the diaphysis with penetrating branches from the epiphyseal vessels and penetrating vessels from the periosteum.

The essayist said that in operating upon these fractures he had not seen blood in the joint or about the bone. If he had looked at the bone itself he might have seen it. Doctor Speed presented a lantern slide which showed

a fracture of the femur, impacted and apparently healed clinically with a large amount of extravasated blood running down into the trochanter and upper diaphyseal portions of the bone, perhaps with penetration into the head. This fracture was over three months old before death occurred, a fracture of the shaft having occurred at the same time and completely healing in the interim. He then showed a second slide made from an impacted fracture, remarking that the impacted type is supposed to give the most favorable prognosis and yet one sees in this slide from the X-ray of a specimen the great amount of atrophy in the trochanteric portion of the bone, the rather increased density from the neck toward the head which may indicate a shutting out of the blood supply and an aseptic necrosis beginning in the head.

A third slide was from a specimen of the neck of the femur four months after fracture, apparently healed clinically. The head may be dead; it is rather dense. Notice the large amount of atrophy in the trochanteric area corresponding somewhat to that hæmorrhagic portion shown in the first specimen, and yet there seems to be some union at the neck. Would that stand use and wear if the patient had survived after these four months?

A fourth slide represented the normal healing fracture of the neck of the femur about fourteen months after the fracture. The bone has regained much of its vitality, the trabecular arrangement supporting the head has been reëstablished so that weight-bearing now without support is entirely possible.

A fifth slide was from a woman who was immobilized in plaster for only eight weeks and then allowed to walk. The use of her leg caused a breaking down of the healing attempt in the bone. This was followed by a succession of slides illustrating various phases of the conditions that may attend fracture of the neck of the femur.

Dr. Daniel F. Jones (Boston) said that at the Massachusetts General Hospital they had been particularly interested in intracapsular fractures of the neck of the femur because they had been unable to get bony union in more than 60 per cent. of the cases. He mentioned that Doctor Smith-Petersen, of the Orthopedia Department, has developed a nail which, in the few cases in which he has used it, has given excellent results. The nail is made up of a head somewhat over one-half inch in diameter. The body of the nail, which has the same circumference, consists of three rather thin strips of metal united at one edge and radiating at an equal distance apart. The trochanter and neck are exposed, the fragments placed in proper alignment, and after measuring the distance from the trochanter to the articular surface of the head, a nail of the proper length to engage the head is driven in through the trochanter and neck into the head up to the articular surface. These patients are put to bed with only light traction for two weeks, after which they are allowed to move the leg freely about the bed, a great boon to the older patients. The nail seems to accomplish two things. It holds the neck and head in apposition, and the flanges make a channel into the head from the neck through which blood-vessels make their way to supply the head. If this does not occur, it is difficult to see why the head does

not atrophy more often. Doctor Smith-Petersen has proceeded slowly with the use of the nail because the Fracture Service at the hospital has been rather opposed to it, but his results have been excellent. He has, Doctor Jones believes, operated upon twenty-five cases there with excellent results in 85 per cent. of the cases.

Dr. Hugh McKenna remarked finally, respecting the time of fixation, he believed these patients, whether treated by the open or closed method, should be placed in the abduction position for a period of sixteen weeks. The important principle to be carried out, in the open operation, even though the autogenous transplant is used, is the impaction of the bony fragments.

PYLORIC OCCLUSION FROM SULPHURIC ACID

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FROM THE SURGICAL CLINIC OF THE UNIVERSITY OF TORONTO

THE taking of corrosive fluids by persons, either by mistake or with suicidal intent, is quite common. In the majority of cases it produces death, and the pathological condition is revealed only at post-mortem. In this case we were able to demonstrate the pathological condition, which was confined to the stomach, and relieve it by operation.

Joseph G., aged thirty-eight, married, a healthy Russian plumber, on the afternoon of December 3, 1929, drank by mistake for gin, three ounces of commercial sulphuric acid. Immediately discovering the mistake, he went to the Toronto General Hospital, and within twenty-five minutes had his stomach washed out, but, unfortunately, was allowed to go home without any instructions as to further treatment. The next day he commenced to vomit blackish fluid, and continued to do so frequently for about three days. At the end of a week he was able to take some nourishment, and then worked for two weeks, eating small amounts. At the end of the third week he commenced vomiting at night large quantities of undigested food mixed with black, foul-smelling material.

He went to a local clinic where an X-ray examination was made, and was informed that there was no obstruction to the outlet of the stomach, and that he would be all right on a diet which they prescribed. However, the vomiting becoming almost continuous, he consulted Doctor Anderson a few days later, and was sent by him into the Wellesley Hospital January 2, 1930; that is, thirty days after having taken the acid.

At this time he had complete obstruction of the pylorus, was dehydrated, breath loaded with acetone, with the smell of putrefaction. Analysis of the stomach content showed absence of free hydrochloric acid, but presence of combined acid, and a large amount of blood. Bile was never present.

January 9 a jejunostomy was done eight inches below the duodeno-jejunal flexure, following the technic of Moynihan. The patient was now fed very satisfactorily, and rapidly improved. The stomach was washed out twice a day for four weeks, and when the return fluid became less offensive, indicating that the sloughing of the mucous membrane had ceased, a barium meal was given. This showed the œsophagus to be free of obstruction, the meal entering the stomach in a normal manner. The pyloric end did not fill nor was there any evidence of anything passing through the pylorus at the end of twelve hours. There were peristaltic waves passing irregularly over the greater and lesser curvatures and the content was about a pint.

With these findings, and the patient now being in a much improved condition, a gastroenterostomy was done February 14.

The stomach was normal in color, the cardiac portion distended, and on tracing it over to the right it was seen to narrow abruptly in the antrum to a width of about an inch. The pylorus was completely occluded by an inflammatory mass three inches in length, extending from the pyloric antrum into the first part of the duodenum. The second portion of the duodenum was firmly adherent to the gall-bladder. This latter structure was distended, grayish-blue in color, and, on first appearance, seemed necrotic. The duodenum throughout the first and second portions was very much narrowed. The liver and pancreas were normal. The mucous membrane of the stomach was hæmorrhagic

in spots, alternating with normal areas and fibrotic areas. A section of all coats was removed which showed the mucous membrane to be desquamating; the glands were regular in size, shape and outline, the interstitial tissue showed marked congestion. The mucosa received showed no evidence of ulceration, but œdema and congestion.

For a week the patient was fed through the jejunostomy tube, his stomach being washed out twice daily. At the end of this time, as there was no gastric retention and the washings were clean, the jejunostomy tube was removed, the opening blocked with gauze, and feeding begun by mouth. The skin was kept protected with vaseline so that there was no irritation from the slight jejunal leak. At the end of three weeks it had closed completely.

The patient, at the present time—three months after operation—is perfectly well, and has resumed work. He is following the routine prescribed for all cases of gastro-enterostomy.

Lord Moynihan[1] states that an examination of the museum specimens and a search into the records show that in cases in which an intensely irritating fluid has been swallowed, accidentally or with suicidal intent, the parts most affected are lips and mouth, pharynx, and the first inch or more of the œsophagus, the lower end of the œsophagus immediately above the cardiac orifice, and the pylorus and pyloric antrum. The greater part of the œsophagus escapes serious damage, though patches of ulceration, or even gangrene, may be distributed throughout it. So far as the stomach is concerned, the worst injury is inflicted on the pylorus, but in severe cases the whole mucous membrane may be affected.

C. B. Keetley likened the appearance of the pyloric portion of the stomach in one of his cases to "a small sausage"; of a second he said, "the pylorus was thickened and so contracted that it would only just admit the closed blades of a pair of polypus forceps"; and of a third that there was "thickening and a very tight stricture of the pylorus."

Thirst is intolerable, and vomiting is an early and constant symptom; even when a very small quantity of fluid is taken, it may be ejected at once or in a few minutes.

Treatment.—In all cases it is of the first importance to see that there is complete abstention from food. When food is given, the process of ulceration is quickened, the ulceration spreads, and gangrene in more or less extensive patches occurs. The chief attempt should be directed to keeping the scalded surfaces sweet and clean. Mouth-washes, sprays, gargles, frequent mopping of the ulcers with gauze swabs, all are useful in helping to insure cleanliness. Two and a half per cent. solution of glucose should be given interstitially.

The safest course would appear to be an early resort to surgery. By means of some operative procedure the feeding of the patient can be insured for a sufficient time to allow healing to take place in the ulcerated patches.

Where the lesion is confined to the pylorus, as was the case with my patient, jejunostomy followed by gastroenterostomy gave us an excellent result and would appear to best meet the indications. Where the lesion is

confined to the œsophagus, then a gastrostomy might be sufficient, but even in this case the jejunostomy would answer the same purpose. If the pylorus is affected as well as the lower end of the œsophagus, a jejunostomy should first be done, to be followed later by a gastrojejunostomy.

Hoebeke and Brasseur[2] describe a case in which the mouth was not burnt, but in which there was evidence of œsophageal and stomach lesions, clearing up without operative treatment.

The cases reported by Chavigny and Laborde,[3] Davezag and Micheleau,[4] and Dujarier and Rosenthal,[5] were fatal, death ensuing within a few hours.

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ALKALOSIS DUE TO PYLORIC STENOSIS SIMULATING NEPHRITIC URÆMIA

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"La fixité du milieu intérieur est la condition de la vie libre et indépendante."
—Cl. Bernard.

Only recently have we come to possess a knowledge of the mechanism and phenomena of alkalosis sufficient to appraise its clinical importance and to bring the realization that by an understanding and use of the factors involved, the clinician may reduce both his morbidity and mortality. The credit for this may, without Chauvinism, be given chiefly to American observers. Our knowledge has grown step by step mainly through investigations into (1) the cause of tetany; (2) the toxic manifestations of intestinal obstruction, particularly high obstruction; and (3) the attention focused upon derangements of plasma structure found in the more frequent condition of acidosis.

Kussmaul, in 1869, described gastric tetany, but for years only fanciful explanations were offered for its occurrence, such as desiccation of tissues, the absorption of toxins from the stomach, and obscure nervous influences. To complicate the situation, the re-discovery of the parathyroids and experimental work by Gley, in 1891, led to the further finding that removal of the parathyroids was followed by tetany. Wilson, Stearns, and Janney (1915), using the newer methods of blood chemistry, elaborated by Lawrence Henderson, Van Slyke, Folin, and others, investigated tetany parathyreopriva and found a marked increase in the alkalinity of the plasma as shown by increased CO_2 combining power. McCann (1918), confirmed this finding and showed that gastric tetany presented the same abnormality of plasma reaction in more marked degree. MacCallum and his co-workers obtained like results in gastric tetany and noted also the extreme fall in blood chlorides which he ascribed to the loss of hydrochloric acid in the vomitus. This loss of acid he believed to be the cause of the alkalosis. He and Voegtlin had already noted another chemical abnormality in parathyroid tetany, namely, disturbance of calcium metabolism, and had found that convulsions could be controlled temporarily by supplying calcium to the blood. They found that tetany, or its minor manifestations, such as twitchings and hyperexcitability of the motor nerves, could be produced by the intravenous injection of large amounts of carbonate or bicarbonate of soda, which indicated the importance of the alkaline imbalance of the blood.

In the meantime, especially during the last fifteen years, a large amount of investigation was being made upon intestinal obstruction. The obvious toxic characteristics of the condition focused efforts upon the discovery of a

toxin or toxins of more or less specific character. Two main schools of thought developed, one which held that the toxin was the result of heightened bacterial activity and absorption in the obstructed loops, the other which sought for the toxin in the perverted digestive and metabolic processes in the obstructed intestine leading to formation and absorption of highly toxic split protein products. Leaving aside this controversy, which is not yet settled, an important by-product resulted. Through all this work, frequent reference was made to an early series of experiments by Hartwell and Hoguet (1912) who found that the toxic effects of obstruction upon experimental animals could largely be prevented if sufficient fluids were administered, in the form of salt solution, to prevent dehydration. The emphasis was placed upon the fluid. The rôle of its sodium chloride content was not considered, as the salt was used in order to make the solution isotonic for purposes of injection. We have seen, in the light of later developments, that while the fluid was important the sodium chloride was even more so.

The clinical fact that high obstruction is more rapidly fatal than low obstruction led to much search for a toxin-bearing area in the upper intestine. This fact has now been correlated with the early and severe chemical imbalance caused by high obstruction.

In 1914, Tileston and Comfort had noted a high non-protein nitrogen in the blood in cases of experimental intestinal obstruction. In 1923, Haden and Orr in three cases of gastroenterostomy, complicated by failure of function of the stoma with severe vomiting, found all the important chemical abnormalities of the plasma previously noted; namely, high nitrogen retention, low plasma chlorides and high CO_2 combining power. They found that efforts at restoration of the normal chemical structure of the plasma gave strikingly beneficial results. This appears to have been the first clinical correlation and application of the growing conception of alkalosis. They followed these observations by experiments upon intestinal obstruction in general and showed that severe alkalosis is a characteristic of this condition. Obstructed animals given plain water died more quickly than those receiving no fluids at all. Obviously, to increase the water intake and thereby the abnormal loss of certain elements of the blood through vomiting and other eliminative channels only aggravated chemical imbalance. This is the reason for the remarkable observations of Hartwell and Hoguet which were for years unexplained. By giving salt they were maintaining the chemical balance of the plasma, thus protecting these animals against the damaging effects of alkalosis. Haden and Orr suggested that chlorides had a detoxifying effect upon the harmful substances absorbed from the bowel in obstruction. Whether such a direct chemical antagonism is present cannot be definitely stated, at present, but it seems more likely that we have to do with two separable noxious factors in intestinal obstruction; namely (1) the absorption of toxins; and (2) chemical imbalance resulting in alkalosis, kidney damage and consequent retention of both endogenous and exogenous toxins.

Important clinical observations were now added by Brown, Eusterman, Hartman, and Rowntree (1923). In eleven cases studied in the Mayo Clinic, they noted as the result of organic obstruction, anatomic or physiologic stasis in the duodenum, a characteristic clinical picture and changes in blood chemistry. Apparently being influenced by the prevailing ideas as to the existence of an absorbable toxin under these conditions they designated this as a duodenal toxæmia. The clinical picture consisted of (1) vomiting of large amounts of thin, serous, bile-stained fluid; (2) dehydration with

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florid complexion, high hæmoglobin, low blood-pressure and asthænia; (3) tetany-like manifestations; and (4) features of shock and urænia. The blood showed low chlorides, high CO_2 combining power and high blood urea and creatinin. They called attention particularly to the renal damage as evidenced by albumin, casts, blood nitrogen retention and decreased excretion of phenolsulphonephthalein. McVicar, in 1925, extended this symptom complex to all cases of high intestinal obstruction showing that a similar toxic effect and identical blood changes occurred. He showed that severe alkalæmia may exist without tetany and that tetany may be anticipated when CO_2 combining power of the plasma passes 100 volumes per cent.

In the meantime, the work of the chemists had given a basis for understanding the phenomena of chemical imbalance of the plasma. It had been found that health demanded the maintenance of a remarkably constant reaction of the blood. Expressed in terms of hydrogen ion concentration (pH) the normal variation fell between 7.3 and 7.5. Normally, the blood reaction is slightly alkaline. In the oxidizing processes of metabolism large amounts of carbonic acid and smaller amounts of lactic, phosphoric, sulphuric and other acids are being formed. In pathological states oxybutyric and diacetic acids are produced. Under the ordinary conditions of life the reaction of the blood tends to become acid. This tendency is counterbalanced by the removal of excess acid through the lungs and excretory organs, through metabolic destruction of certain acids and by absorption of neutralizing basic substances which are constantly taken with the food. Likewise, a surplus of base may be neutralized by the acids produced or they may be excreted through the kidneys and intestinal tract. In order to accomplish this transformation and transportation within the body, use is made of certain labile substances which are known as buffers. The most important of these are hæmoglobin and the phosphates and bicarbonates. The regulation of blood reaction is accomplished chiefly by the latter owing to the ease with which carbonic acid may be blown off through the lungs in the form of its acid radical, carbon dioxide, or in case of need, it may be held in the blood for combination with base to form base bicarbonate, the reaction of which is weakly alkaline. The mechanism is remarkably efficient but it may fail because of respiratory abnormalities or because the accumulation of acids or alkalies within the body may surpass its regulatory power. Van Slyke has shown that in addition to the normal balance there are eight possible abnormal states. Alkali may be deficient or present in excess. In either case it may be compensated or uncompensated. If compensated the blood reaction remains normal though the blood plasma structure is altered: if uncompensated, the reaction of the blood shifts in accordance with the reaction of the substance present in excess. The same is true of the acid regulator carbon dioxide which may be in excess or deficient in amount and in each instance may be compensated or uncompensated. All these abnormal conditions have been produced experimentally and it is probable that all may occur in man under certain conditions. The attention of the clinician was directed first toward acidosis, i.e., compensated and uncompensated alkali deficit. These are seen most often in diabetes and nephritis, in the

former instance being due to the accumulation of diacetic and oxybutyric acids, the products of incomplete carbohydrate metabolism, and in nephritis to the failure of elimination of the non-volatile acids formed during ordinary cellular metabolism. For a better account of the chemistry involved one should consult the descriptions of Gamble and Hartman or the more detailed scientific expositions of Van Slyke and Wilson. The clinician should acquire a certain familiarity with the underlying principles since it is not easy to furnish a rule of thumb for application to therapy in all cases. We have seen the abuse of sodium bicarbonate as a routine post-operative measure and it is not at all well known that the ketone acids may be present in the urine even in alkalosis, thus leading to the administration of alkalies which aggravate the condition.

If we may judge by the literature it would seem that the clinical importance of alkalosis has received insufficient attention. Hardt and Rivers, in 1923, called attention to the dangers of over-alkalization in the medical treatment of peptic ulcer. They found that ill effects were more likely to occur in patients whose renal function was impaired, doubtless owing to the difficulty of excretion of the excess of alkali in such cases. Cases were encountered in which the excessive use of alkalies caused severe renal damage, uræmia and, in some instances, typical tetany. Case reports and clinical papers have been contributed to the subject by Harrison and Perlzweig (1925), Ellis (England, 1926), Bothe (1926), Larson and Pulford (1928), Andrews and Bump (1928), Rathery and Rudolph (France, 1928 and 1929). The Italians have contributed a number of clinical papers.

The renal phenomena associated with alkalosis are interesting and important. Apparently there is a nephrosis which tends to be severe. There is evidence of damage to the glomeruli and renal epithelium as shown by albumin, casts, and not infrequently red blood-cells in the urine. Decreased excretory power is reflected in low elimination of phenolsulphonephthalein and rapidly mounting retention of blood nitrogen. In certain cases the picture is that of uræmia. Tucker, in 1922, reported eight cases of uræmia following gastroenterostomy. The first four cases died; the fifth developed tetany, for which he was given calcium chloride and salt solution with happy results. We can now realize that this type of uræmia is due chiefly if not entirely to alkalosis. A few non-operative cases of alkalosis simulating uræmia have been reported by Rowntree, Ellis, and Rathery and Rudolph. In some cases the underlying cause was not suspected and the patient incorrectly treated by eliminative measures, no attention being paid to the chemical imbalance. The small amount of data available show this to be a highly fatal procedure.

The following case is an example of the ease with which this error may occur and the importance of treating such cases from the standpoint of chemical imbalance.

CASE.—On October 19, 1929, a man, H. C., aged forty-one, was admitted to the Presbyterian Hospital, in Philadelphia, complaining of drowsiness, loss of weight and

vomiting. Seven weeks previously he had been admitted to the Presbyterian Hospital under the care of an internist. At that time he was semi-stuporous, irrational and occasionally vomited profusely. On that admission he was successfully treated under a diagnosis of nephritis, uræmia and general visceroptosis. This diagnosis was based upon a history of somewhat similar attacks covering a period of ten or fifteen years; a pallid, somewhat anæmic appearance similar to that of chronic nephritis (Hæmoglobin 78 per cent.; red blood cells, 4,100,000; white blood cells, 9,200); high blood urea nitrogen (117 milligrams per 100 cubic centimetres); persistent low specific gravity of the urine rarely rising above 1010; the presence of considerable albumin with granular casts and red blood-cells in the urine; a low phthalein elimination (on the fifth day, first hour, 300 cubic centimetres, 12 per cent.: second hour, 60 cubic centimetres, 16 per cent). The reaction of the urine was alkaline. The blood-pressure was low (108 systolic; 68 diastolic, and on successive examinations frequently below 100 systolic).

On forced fluids and eliminative measures, he responded quickly, passing large amounts of urine, eliminating the blood urea nitrogen, the clinical condition improving *pari passu*.

It was obvious that he had gastric retention, and his digestive history was interesting. After a severe attack of whooping cough at about fourteen years of age, he began to have stomach trouble, which continued up to the present. In the beginning he had pain after meals but for many years pain had not been a conspicuous feature. Instead he had discomfort and a feeling of fulness whenever he indulged heartily in food or liquids. He had found that he could make himself comfortable by emptying his stomach and frequently used the stomach tube for that purpose.

Seven years previously a gastro-intestinal X-ray examination had been made from which a diagnosis of gastroptosis was made. No evidence of ulcer was detected at that time, it was said. Physically, he was the typically ptotic type.

On this occasion also, after he had improved, an X-ray study was made with the following conclusions: "Visceroptosis of sufficient degree to account for symptoms of fairly severe grade. Part of six-hour retention can be thus explained. The fact that there is a large irregular duodenal cap with a constant deformity strongly suggests adhesions or ulceration, probably the former."

I saw him at this time with Doctor Phillips and in view of his obvious improvement and the doubt as to an organic condition other than ptosis, it was decided to send him home to follow a careful dietetic and general regimen adapted to the treatment of ptosis.

In a month he had gained twenty pounds and felt very well. Then he began to have trouble with his stomach. He would vomit at night, and frequently relieved himself with the stomach tube. In a week he was readmitted with symptoms of uræmia. Again his blood urea nitrogen was high (62 on admission, 68 next day, 76 next day). The urine was alkaline, specific gravity 1010, and contained many granular casts. Subsequently red blood-cells appeared. Phenolsulphonethalein elimination in two hours was 23 per cent. Forced fluids and eliminative treatment similar to that employed on his former admission failed. He became unable to retain anything by mouth and required lavage for gastric dilatation. On the seventeenth day, he was irrational with a blood urea nitrogen of 84.7. He was very restless and exhibited twitching of the muscles but at no time was carpo-pedal spasm or the definite evidences of tetany observed. Trousseau's and Chvostek's signs were never elicited. At this time (October 28) I saw him and was impressed with the similarity of his condition to that observed in miscellaneous surgical cases in which alkalosis was present. Blood chemistry at this time showed blood urea nitrogen, 100; chlorides 180; CO_2, 98 volumes per cent. The low chloride concentration (one-third normal), and high CO_2 confirmed

the idea. (It is worthy of note that he had been kept on a salt-free diet because of his nephritis.)

It was decided to concentrate all treatment upon the restoration of chemical balance.

October 29.—Continuous hypodermoclysis with normal salt solution was given. Five hundred cubic centimetres of 2 per cent. salt solution and 250 cubic centimetres 10 per cent. glucose solution were administered intravenously. Ten cubic centimetres of 10 per cent. calcium chloride solution were given with the intravenous solution. The following day (October 30) the urine, which had fallen to a small amount voided incontinently, had increased to over 3000 cubic centimetres, blood urea nitrogen was 98, chlorides 363, sugar 176, CO_2 73. He regained consciousness but was still semistuporous. With a view to reducing the urea concentration in the blood an exsanguination
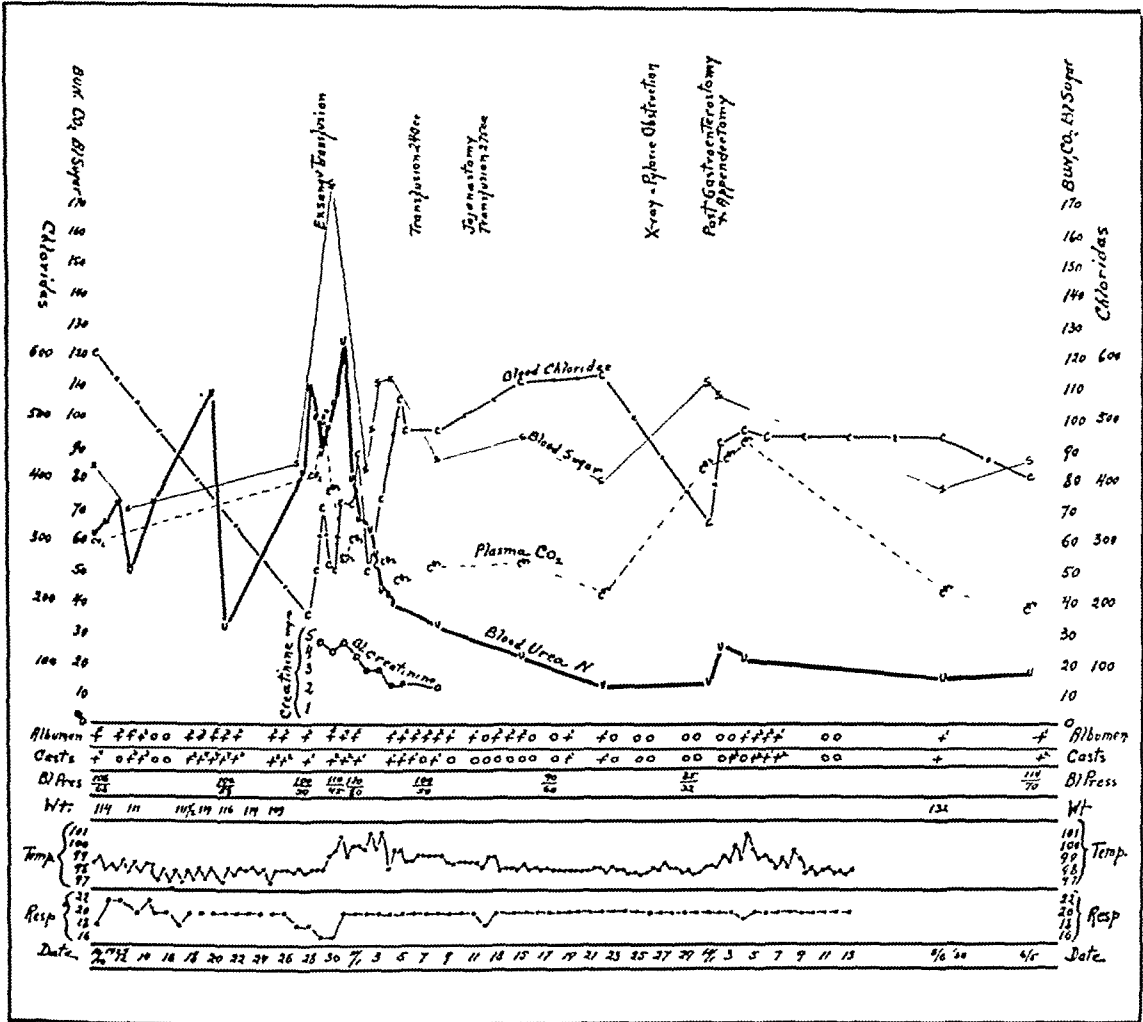
transfusion was done, about 200 cubic centimetres of dark viscous blood being withdrawn and replaced by 400 cubic centimetres. Under this treatment two days later:

November 1.—Conscious, voiding voluntarily, blood urea nitrogen 68, chlorides 432, sugar and CO_2 normal. A curious phenomenon was noted. Although nothing was given by mouth a continuous gastric hypersecretion occurred causing dilatation of the stomach and requiring siphonage, which was carried out by the Jutte tube. As much as 2500 cubic centimetres of dark bile-stained fluid was withdrawn daily. This militated against restoration of the normal sodium chloride balance and caused a rise in blood urea nitrogen and a fall in chlorides. On the second day (November 3) it was noted that the blood chlorides had fallen to 280. Blood urea nitrogen had dropped to 57, sugar and CO_2 still normal. Two per cent. intravenous salt and 10 per cent. glucose was given again in addition to normal salt solution by hypodermoclysis. The following

day (November 4) the blood chlorides had mounted to 396, blood urea nitrogen was again reduced to 46.2.

On November 6, one week after beginning this treatment, the blood chemistry had reached normal except for the blood urea nitrogen, which was still moderately elevated: blood urea nitrogen 33.95, chlorides 528, CO_2 46 volume per cent. A second transfusion was given this day. As the chlorides approached normal, gastric hypersecretion diminished. It was impossible, however, to induce the stomach to empty through the pylorus.

Water and fruit juices were tried but after a period of hours could be withdrawn with some excess, evidently from the stomach and duodenum. For five days this continued, the patient being sustained by parenteral fluids and another transfusion.

November 11.—A jejunostomy was then made under local anæsthesia. By this means it was possible to supply fluids and nourishment by bowel. This was continued for two weeks, nothing whatever being given by mouth. Each day about 200 to 300 cubic centimetres of bile-stained fluid were withdrawn from the stomach. At this time to determine the condition of the pylorus 250 cubic centimetres of barium mixture were given by mouth but none passed through the pylorus in six hours.

November 30.—Being convinced that there must be mechanical interference, it was decided to explore, which was done under spinocaine. This anæsthetic was selected in spite of the low blood-pressure (at this time about 90 systolic) since it was felt that the danger of circulatory collapse could be met more safely than the after affects of general anæsthesia upon such a debilitated individual. Whether this was good reasoning or not, at any rate, after administration of the preliminary ephedrin, the blood-pressure began to rise, reaching 108 in ten minutes. A blood transfusion was started simultaneously with the operation. The blood-pressure continued to rise and reached 128 in twenty minutes, and the patient's condition gave no concern throughout the operation, which lasted fifty-five minutes.

A typical pyloric stenosis was found, evidently the result of an old, healed, duodenal ulcer. The lumen would probably not have admitted an ordinary lead pencil. A posterior gastroenterostomy and appendectomy were performed.

Here again a curious phenomenon was noted. It was felt that even should the gastroenterostomy fail to work for a time, it would be a simple matter to carry the patient along by his jejunostomy which was still present and through which he had been entirely sustained for over two weeks. However, the attempt to use the jejunostomy after operation led to the discovery that under the new conditions all food and fluids which were introduced into the jejunum were promptly reversed into the stomach and there accumulated until the stomach became distended and required relief by lavage. It was again necessary to resort to hypodermoclysis and intravenous administration of saline and glucose. On the third day it occurred to me to reintroduce into the jejunum what was being lost through the stomach. Since that time I found in Wilkie's Murphy oration before the American College of Surgeons that he had done a somewhat similar thing in a case where he had made two enterostomies. He suggested that possibly there is some principle elaborated in the upper intestines which is required for stimulating normal peristalsis in the lower portion. In any event, after introducing the gastric contents secured by lavage into the jejunostomy opening, reverse peristalsis soon stopped and all was smooth sailing thereafter.

December 19, 1929.—The patient left the hospital three weeks after operation. Since that time he has gained twenty-three pounds. Except for occasional heartburn, he has felt entirely well.

Reëxamination May 5, 1930, by Dr. John Eiman.

> Blood-pressure: systolic, 114; diastolic, 70.
> Blood urea nitrogen—18.2 milligrams per 100 cubic centimetres.
> Sugar—88 milligrams per 100 cubic centimetres.

Creatinin—1.8 milligrams per 100 cubic centimetres.
Chlorides—402.7 milligrams per 100 cubic centimetres.
Plasma CO₂—38. Vols. per cent.

Urinalysis

	Morning	Evening
Specific gravity	1017	1015
Reaction	acid	acid
Albumin	trace	trace
Glucose	none	none

Microscopical : Morning specimen, three to six hyaline, light granular and coarsely granular casts per high power field. Few leucocytes. No erythrocytes.

Evening specimen, six to eight finely and coarsely granular casts per high power field, many cylindroids. Several clumps of leucocytes. No erythrocytes.

Phenosulphonephthalein :

	Amount	Dye
First hour	40 cubic centimetres	18 per cent.
Second hour	40 cubic centimetres	15 per cent.
Totals	80 cubic centimetres	33 per cent.

There is still evidence of renal damage and insufficiency. He shows some oral sepsis which may be playing a rôle. This will be cleared up and its influence determined.

Comment.—The relation of the kidneys to alkalosis deserves more extended study. Dr. John Eiman, Pathologist of the Presbyterian Hospital in Philadelphia, believes that a specific and recognizable type of glomerular damage and nephrosis is associated with this condition. It is certain that a high degree of irritation and actual cellular damage are the early consequences of this form of plasma abnormality. Its effects may closely simulate uræmia. As a matter of fact, the result is a form of uræmia and the depression of the nervous system due to urea poisoning may counterbalance the hyper-excitability of nerve structures characteristic of alkali tetany, thus obscuring a clinical diagnosis.

Conversely, when renal impairment already exists the liability to both acidosis and alkalosis is increased owing to the faulty eliminative function, which is one of the important aids in maintaining chemical balance of the blood. While the common change in nephritis is in the direction of acidosis, it must not be overlooked that when conditions tending to produce alkalosis are present the shift towards alkalinity is likely to be exaggerated. There is then a vicious circle. The kidneys are further damaged and function more impaired. In acute cases the outcome is speedily fatal unless the fault be detected and repaired. In recurring or chronic alkalosis a permanent glomerulonephritis may possibly result.

The reaction of the urine may and frequently does remain acid in severe alkalosis. This is usually due to the fact that owing to the loss of body

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fluids containing base as well as acid, there is an absolute deficit of base even though it preponderates in the blood. The acid solutes of metabolism pass the kidneys more readily, causing the urine to give an acid reaction.

It is important also to realize that there is no necessary parallelism between the ketone acids and the normal acid regulators of the blood. The finding of diacetic acid and oxybutyric acid in the urine does not preclude the existence of alkalosis and the decision to administer alkalies should not be based upon such finding alone.

Blood chemical examinations are essential to the diagnosis and accurate therapy. The chief indices are the CO_2 content of the plasma and the blood chlorides. The pH is less delicate since it may not be affected so long as the alkalosis is compensated. If we except the alkalosis which is due to excessive administration of alkalies or to hyperventilation, we may say that under clinical conditions alkalosis results from diminution of chlorine in the blood which thus frees base to unite with bicarbonate to form alkaline substances. The obvious therapy, therefore, is to restore chlorine, which may readily be done by giving sodium chloride through the available avenues. Abundant normal salt solution not only counteracts dehydration but replaces the lost chlorine. Hypertonic solution given intravenously should be employed in severe cases. Given familiarity with the conditions likely to be complicated by alkalosis, its development is best prevented by liberal infusions of salt solution. Result should be checked by blood chemical estimations. The use of glucose is of great value in protecting protein against destruction, supplying energy and aiding elimination. Blood transfusions have shown their clinical utility.

CONCLUSIONS

Alkalosis, though less common than acidosis, is a definite and important condition demanding clinical recognition and specific treatment. It may be suspected especially in conditions of profuse and prolonged vomiting, and in obstructive states, mechanical or physiological, involving the stomach and upper intestinal tract.

Symptomatically it shows itself by (1) vomiting, usually profuse, often by gastric hypersecretion and dilatation; (2) dehydration with asthænia and reduced blood-pressure; (3) restlessness, irritability, nervous twitchings and, in certain cases, typical tetany; (4) in the later stages, stupor and coma resembling uræmia of nephritic origin.

The urinary findings are those of acute glomerulonephritis and phenol-sulphonephthalein elimination is diminished. The blood chemistry is diagnostic, the essential changes being diminution in chlorides and increase in CO_2. Nitrogen retention is also an early and significant sign.

Treatment consists in restoring the chemical balance of the blood plasma. In severe cases intravenous therapy is indicated and should accompany, or, if possible, precede urgent surgery.

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DISCUSSION: DR. DONALD CHURCH BALFOUR, of Rochester, Minn.. said that he had seen the exact counterpart of the patient described by Dr. Pfeiffer and had seen the same spectacular results come from the use of salt and glucose intravenously. A point he would like to make. however. is that before this serious toxemia develops there are usually signs which will permit prevention of this toxemia. Any patient who shows any evidence of gastric retention. should be put in the hospital to immediately determine whether there are any changes in the blood urea or the carbon dioxide combining power or the chlorides. and if there are changes. no matter how slight they may be. the patient is given salt and glucose intravenously.

In this way we have practically eliminated any serious cases of toxemia from high gastro-intestinal obstruction.

THE SERUM TREATMENT OF BACTERÆMIA DUE TO HÆMOLYTIC STREPTOCOCCUS

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from the selina b macilhenny research fund of the presbyterian hospital of philadelphia

The treatment of septicæmia or, as it is better known today, of bacteræmia of whatever origin remains a problem which to our minds still awaits a satisfactory solution. As a clinical condition, and aside from its occurrence as a terminal phenomenon, it presents a rather frequent and sufficiently urgent complication which oftentimes exceeds in severity and danger the original lesion. This applies especially to the commoner surgical infections, particularly the bacteræmias of staphylococcic and streptococcic origin. There is no consensus of opinion today as to the value of any one method of treatment. In this study we have confined ourselves mainly to the subject of blood-stream infections due to the hæmolytic streptococcus. Bacteræmias due to other types of streptococci or the staphylococcus present entirely different problems.

The numerous contributions in recent years on the treatment of bacteræmia by chemotherapeutic agents have attracted great attention and have more or less diverted the attention of surgeons from the older method of serum treatment. Aside from the surgical treatment of the primary focus, the importance of which is well recognized, the usual practices of today include four different methods of attack. These include general supportive treatment, chemotherapy, blood transfusion, and finally serum therapy. From our observations in various clinics the last seems to be a poor fourth. This attitude seems somewhat anomalous in view of the recognized progress which has been made in the control of streptococcic infections in other fields, notably in scarlet fever and erysipelas.

The recent withdrawal by the American Medical Association of antistreptococcic serum from the list of New and Non-official remedies is a significant indication of the trend of surgical opinions and practice. The questionnaire submitted by Novak[1] to the heads of twenty-five clinics in the United States showed, in the majority of instances (sixteen), that experience with antistreptococcic serum had been disappointing, and one surgeon was apparently ignorant of its existence. Others (eight) found it to be of some value. We are not convinced that unqualified rejection of serum treatment is justified. Our personal experience has been quite to the contrary.

With regard to the other methods of treatment already mentioned, in any case the surgical control of the primary focus, if demonstrable, by elimination, sterilization or drainage, supersedes in importance all other procedures. Without such control all other measures are sure to be futile in the great majority of instances. Reference has been made to general supportive treatment. This is too often taken for granted in the treatment of all prolonged

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infections. The accelerated metabolic rate attending fever makes increased demands on stored carbohydrate, and, if this be not maintained, the fats are called upon and oftentimes their combustion is incomplete and results in the formation of acetone bodies. Likewise, failure to maintain the water balance is a common error. Anorexia and gastric irritability often interfere with administration of fluids and nourishment; if this be the case, one should utilize the bowel, subcutaneous or intravenous routes.

Blood transfusion and the perfection of methods which render its use safe and convenient, as well as its undoubted value in certain cases, help to explain its popularity. Its non-specific antigenic action is also of value both by itself and as an adjuvant to other methods of treatment. One must not overlook the danger of overloading the circulation and throwing serious strain on the heart by too large and too frequent transfusions. With regard to chemo-therapy, we believe the results obtained up to the present time by the intravenous use of chemotherapeutic agents have been disappointing to the majority of conservatively minded surgeons. However, we would not belittle the attempts to develop bacteriotropic chemotherapeutic agents. It is possible that in the future this problem will be solved along these lines. The brilliant results obtained in the treatment of syphilis have stimulated immunologists and chemists the world over to duplicate this success in the control of bacterial infections, but no reagent so far developed has, in our opinion, met the test in its application to clinical practice in the types of infection under consideration.

The material presented in this paper consists of forty-three cases of streptococcus hæmolyticus infection in which the blood cultures were positive. This number is small but is fairly representative of cases as they occur in general hospital practice. The great majority of the cases tabulated as treated

TABLE I

Streptococcus hemolyticus bacterœmia cases

Primary Focus	Group I Died without serum or too small amounts while in extremis	Group II Recovered without serum	Group III Died with serum	Group IV Recovered with serum	Total
Abortion	4	1	2	5	12
Puerpural Sepsis	0	0	0	1	1
Otitis Media, Mastoid-itis or Sinusitis	4	2	0	4	10
Respiratory Tract	2	0	0	1	3
Infection of Extremities or Cellulitis	6	2	2	4	14
Ulcerative Carcinoma of Uterus	1	0	0	0	1
Undetermined	2	0	0	0	2
Total	19	5	4	15	43

Recovered without serum treatment 5 of 24 cases or 21 per cent
Recovered with serum treatment 15 of 19 cases or 79 per cent

by serum have been under our personal observation and control, either as surgeon or consultant. The majority of contributions on this subject have been based upon studies of series of cases from gynecological and obstetrical services. In our series, however, this is not the case. A large proportion of cases was observed in the general surgical service, in addition to those from the gynecological and obstetrical, and otolarnygological wards.

In an evalution of any method of treatment of this condition it is necessary to recall the underlying pathological processes. All of this has been so clearly brought to our attention in the splendid article presented before this Association five years ago by Dr. Walton Martin[2] that it hardly needs repetition in detail. We must appreciate that it is not the problem of an infection in a closed system such as the circulation. The presence of infected thrombi in the circulatory tree forms an exception. It is the intermittent or continuous discharge of bacteria into the blood-stream; the reactions of the natural defense mechanism of the body, manifested either by stimulation or exhaustion of the hæmopoietic system; the rôle played by the reticulocytes; the action of the non-specific immune substances in the body fluids; and in uncontrolled cases the development of secondary foci, extensive hæmolysis and toxæmia with its attendant changes in the parenchymatous organs.

In our own observations in cases of bacteræmia due to pyogenic organisms we have been impressed with the necessity of differentiation between these cases which are characterized by what we call the "shower type" of infection, from a "massive invasion" of the blood-stream by bacteria. In the shower type of blood-stream invasion positive blood cultures are obtained either before or immediately after surgical intervention for an acute primary focus, such as drainage of an infected hand or the removal of infected thrombi from the lateral sinus. In such cases the natural defense mechanism is usually capable of destroying the bacteria without further therapeutic measures. The further invasion of the blood-stream is checked by whatever surgical method has been employed. Any additional therapeutic agent used at this time naturally is given credit for the sterilization of the blood-stream. In this type of infection when cultures are made on blood agar plates, only a few colonies of organisms are found.

In cases illustrating the "massive type" of invasion, blood-culture plates reveal hundreds of colonies of bacteria per one cubic centimetre of blood, and the surgical treatment of the primary focus does not lead to the abatement of the symptoms. Under such conditions of overwhelming infection the natural defense mechanism is rapidly exhausted and the chain of symptoms already described follows as a natural consequence. This is aside from the disputed question as to whether or not bacteria multiply in the blood-stream itself.

The two types of blood-stream invasion by bacteria are best illustrated by what is so often seen in cases of osteomyelitis, although in these cases the blood-stream is frequently sterile by the time the patient comes under the observation of the surgeon, the stage of "shower invasion" having already

passed. In neglected cases a "massive invasion" takes place from the localized infection in the bone. In a few instances the period intervening between the primary "shower invasion" and the secondary overwhelming "massive invasion" is very short or may be entirely absent. In any event other foci rapidly develop either in other bones or connective tissue, lungs, joints or the viscera, depending in some degree on the specificity of attraction manifested by different strains. This illustration of our point is furnished by a surgical lesion, osteomyelitis of hematogenous origin due to staphylococcus aureus. The cases which we are including in this paper are of different origin. While we have been interested in the problem of both types of bacteræmia we have found it necessary to attack the problem of staphylococcus infection from another angle, due to failure to obtain a satisfactory bacteriocidal serum for the staphylococcus aureus.

Some explanation seems necessary for the attitude of the surgical profession toward the use of serum therapy in streptococcus hæmolyticus bacteræmia. Such explanation is not far to seek. It is now a good many years since the streptococcus serum has been available for use. Nor is there any question of the failure of the old monovalent serum to reduce mortality. There are a number of strains of hæmolytic streptococcus which react differently to biological tests, consequently, the use of a polyvalent serum is imperative. It is with the consideration of the modern polyvalent serum that we are concerned in this study.

Group I.—Nineteen cases of bacteræmia died either without serum treatment or received insufficient amounts of serum while *in extremis*. This group emphasized the importance of administration of sufficient amounts of serum

TABLE II

Group I. Died without serum or received too small amounts when in extremis

No.	Name	Age	Diagnosis	Serum	Transfusion	Mercurochrome
1	O. K......	36	Acute respiratory infection	o	o	o
2	S. B......	50	Respiratory infection	o	o	o
3	M. J. N...	38	Acute abdomen	o	o	o
4	M. C.....	36	Abortion	o	o	o
5	M. R.....	31	Abortion	o	o	o
6	J. L.......	26	Abortion	o	o	o
7	B. E......	48	Ulcerated carcinoma of uterus	o	o	o
8	D. R......	23	Infected knee joint	o	o	o
9	W. H. W..	66	Crushed hand	50 cc.	o	o
10	J. M......	36	Mastoiditis	o	o	o
11	G. M.....	20	Abortion	100 cc.	o	o
12	E. N......	7	Meningitis	o	o	o
13	L. W......	68	Infected leg	o	o	o
14	E. C......	64	Gangrenous foot	o	o	o
15	H. O'R...	10	Otitis media	o	o	o
16	H. C. O...	33	Buerger's disease	90 cc.	o	o
17	A. V. T...		Infected hand	o	o	o
18	G. W.....	22	Pelvic cellulitis	o	o	o
19	T. Z......	30	Infected hand	100 cc.	o	o

early or before marked degeneration of parenchymatous organs takes place.

Group II.—Five cases in this group recovered without the use of serum. This group deserves particular attention: it shows that a number of cases of streptococcus hæmolyticus bacteræmia do recover without any immunologic or chemotherapeutic treatment. Cases No. 4 and No. 5 belong definitely in the so-called "shower invasion" group and the blood-stream became sterile after establishment of satisfactory drainage of the primary focus. Cases No. 1 and No. 2 also recovered without the use of serum. In Case No. 1 an infected thrombus was removed from the lateral sinus and in Case No. 2 mastoidectomy was done but phlebitis of the lateral sinus must have existed. In both patients the temperature varied from 101° to 105° for forty or fifty days respectively. Administration of serum might have shortened the period of morbidity.

TABLE III

Group II. Recovered without serum

No.	Name	Age	Diagnosis	Serum	Trans-fusion	Mercuro-chrome	Remarks
1	A. J. D...	9	Acute mas-toiditis, thrombosis, lateral sinus	0	0	0	Mastoidectomy. Removal of thrombus from lateral sinus. High temperature for forty days
2	P. P......	14	Acute mas-toiditis	0	0	0	Mastoidectomy. High temperature for fifty days
3	P. P......	24	Abortion	0	0	0	High temperature for thirty days
4	J. W.....	54	Cellulitis of hand	0	0	0	Incision and drain-age
5	Dr. W....		Cellulitis of hand	0	0	0	Incision and drain-age

Group III.—Consists of four cases, all of which died in spite of large doses of antistreptococcic serum. Two of these cases were autopsied. Case No. 1 showed extensive septic thrombi in the veins of both broad ligaments, particularly the left and a septic thrombus in the left ovarian vein extending into the left renal vein and projecting into the vena cava. This patient was given, before the serum treatment was begun, 250 milligrams of mercuro-chrome. This produced uncontrollable bloody diarrhœa, but no beneficial influence on the general condition of the patient. Intravenous administration of 550 cubic centimetres of serum in three days did not change her condition, neither did a blood transfusion of 500 cubic centimetres. Autopsy on Case No. 4 revealed a perforated uterus and acute generalized fibrino-cellular peritonitis. There was no autopsy in Case No. 3. Shortly before death, however, there were definite evidences of peritonitis.

Group IV.—Includes fifteen cases, all with a "massive" blood-stream invasion by the hæmolytic streptococcus. In all fifteen cases massive doses of serum were used, and all of them recovered. Surgical measures were

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TABLE IV

Group III. Died with serum

No.	Name	Age	Diagnosis	Serum	Trans-fusion	Mercuro-chrome	Remarks
1	L. M.....	42	Abortion	550 cc.	500 cc.	250 mgs.	Autopsy—Abscesses in wall of uterus. Thrombosis of veins of broad ligaments, left ovarian and renal veins
2	T. M.....	31	Cellulitis of leg	240 cc.	0	0	
3	A. T.....		Abortion	360 cc.	0	0	
4	M. D.....	21	Abortion	250 cc.	0	0	Autopsy:—Ruptured uterus, peritonitis

employed in the treatment of the primary foci where indicated. Blood transfusions were given in some cases.

In our experience, polyvalent antistreptococcic serum, or, for that matter, any other serum or chemotherapeutic agent, does not exert any beneficial

TABLE V

Group IV. Recovered with serum

No.	Name	Age	Diagnosis	Serum	Trans-fusion	Mercuro-chrome	Remarks
1	C. H.....	25	Abortion	650 cc.	0	0	
2	B. B.....	23	Abortion	150 cc.	0	0	
3	J. M.....	34	Abortion	350 cc.	0	0	
4	E. S.....	28	Abortion	100 cc.	0	0	
5	M. S.....	24	Abortion	750 cc.	0	0	
6	H........		Puerpural sepsis	700 cc.	0	0	
7	L. R.....	4	Otitis media	230 cc.	0	0	
8	H. G.....	14	Infected toe	290 cc.	0	0	
9	S. C.....	19	Respiratory infection	158 cc.	0	0	
10	V. C.....	8	Mastoiditis; lateral sinus; thrombosis	200 cc.	4 of 200 cc. each	0	Mastoidectomy; removal of thrombus
11	M. W....	7	Lateral sinus; thrombosis; mastoiditis	150 cc. horse 150 cc. bovine	6 of 150 cc. each	0	Mastoidectomy; removal of thrombus 75 cc. of Pregel's iodine
12	M. D.....	36	Laceration forehead, orbital cellulitis				
13	M. N	31	Cellulitis of leg				
14	B. H.....	23	Cellulitis of leg	220 cc. bovine			
15	C. D.....	26	Abortion	460 cc.	0	0	

action either on primary or secondary foci. Such foci, if demonstrable or accessible, must be treated surgically. Extreme care, however, must be exercised in handling any particular focus or organ, especially the infected

uterus. We accept the dictum that the less this organ is manipulated, the greater the chance for recovery. In instances where the uterus contains pieces of infected placenta, or the entire product of conception, without removal of this primary source of infection, nothing will be accomplished by serum treatment. Likewise, if infected thrombi are present in the blood-vessels or on the heart valves, even successful sterilization of the blood-stream will avail nothing; the blood-stream will become reinfected in a short time from these points. Furthermore, even in the absence of secondary foci or thrombi, serum treatment will fail if the administration is delayed until extensive degeneration of the parenchymatous organs has taken place. Systolic pressure usually is an excellent index; if it falls below 100 it usually means marked toxic changes in the myocardium or dilatation of the heart.

The best results with antistreptococcus serum are obtained when the serum is administered early and in sufficient quantities intravenously before the development of secondary foci or thrombi and marked degeneration of the parenchymatous organs. In this series we have employed from 100 to 850 cubic centimetres in each case. As a rule, if 200 cubic centimetres of serum produce no definite improvement in the general condition of the patient or decrease in the number of bacteria in the blood-stream, further administration will be useless.

Method of administration.—Administration of serum, especially intravenously, should be done with extreme caution. We must remember that we are introducing into the circulation a foreign protein, horse or bovine serum, and that many individuals are naturally sensitive or have become sensitized to different proteins, particularly to horse serum. One should question not only the patient, but also investigate the family history about asthma, hay fever, rose cold, urticaria, angioneurotic œdema and sensitiveness to foods or animals, especially the horse.

We have two cases, both sons of surgeons, who gave at first a negative personal and family history. When the introdermal tests turned out to be positive, both fathers announced that in the years gone by one was subject to hay fever and the other to rose cold. Both sons were truly allergic to horse serum. If this be the case, administration of horse serum, especially intravenously, very likely would kill the patient in anaphylactic shock. Desensitization of such individuals is, as a rule, impossible. Sensitiveness to bovine serum is less common, but the safety of its use should not be taken for granted without the proper tests.

The patient should be questioned about previous injections of serums, such as diphtheria or tetanus antitoxin or other sera, including diphtheria toxin-antitoxin mixture for immunizing purposes. Even in cases with a negative history, the intradermal test should be done. These patients, as a rule, can be desensitized satisfactorily by giving subcutaneous injections of serum at two-hour intervals starting with 0.01 cubic centimetre and then increasing to 0.1, 0.2, 0.5, 1.0, 2.0, and 5 cubic centimetres. After this it is safest to

give five and ten cubic centimetres intramuscularly at the same interval, before proceeding with intravenous administration.

To carry out the skin test, inject *intradermally* about 0.1 cubic centimetre of the serum to be used or until a wheal about seven or eight milligrams in diameter is produced. If the test is positive, in ten or fifteen minutes the wheal will increase considerably in size and will be surrounded by a fairly wide zone of hyperæmia; if negative, the wheal will only slightly increase in size, and there will be only a line of hyperæmia. In positive cases desensitization should be carried out. If the test is negative, one may proceed with the intravenous injection of the serum. We must remember, however, that negative history and intradermal test are not absolute indication of absence of protein sensitization. Hence, the first dose of serum intravenously should be given with extreme care. Dilute the serum with physiological salt solution about 1:20 and introduce it very slowly by means of intravenous apparatus so that the patient does not receive more than twenty cubic centimetres of the diluted serum in the first ten minutes. Before the beginning of the intravenous injection have ready for use in a syringe adrenalin and atropine sulphate. Should anaphylactic shock develop, these drugs will be needed immediately. Fortunately, we have experienced no serious difficulties in this series. We have had to stop the administration of the serum and administer adrenalin and atropine only in two cases. After the lapse of ten minutes, the rest of the serum may be added to the reservoir and administered quite rapidly. At subsequent injections the serum can be administered more rapidly, either directly from the original container or with a syringe. Needless to say, the serum injected should be at body temperature. We usually give twenty-five or fifty cubic centimetres at the first injection, and fifty or 100 cubic centimetres at a later time. It is better to give two or three smaller injections in twenty-four hours than one large dose. Blood cultures should be taken every day until they become negative. One should plan to administer all the serum intended to give in six days, since after that time the patient may become sensitized to the serum and administration after the lapse of that period may lead to disastrous results. Should the patient be sensitive to horse serum or should the injections be prolonged beyond the six-day period, one may use the antistreptococcic bovine serum, which, fortunately, has been available in the last few years.

CONCLUSIONS

1. It has been shown in the analysis of forty-three cases of hæmolytic streptococcus blood-stream infections that polyvalent antistreptococcic serum is of a decided value in the treatment of these cases.

2. Twenty-one cases received no serum, four cases received insufficient amounts and in late stages. Five cases, or 21 per cent., recovered. Nineteen cases, or 79 per cent., died.

3. Nineteen cases were treated under conditions which were satisfactory

for the test of the value of the serum. Four cases, or 21 per cent., died and fifteen cases, or 79 per cent., recovered.

4. The serum had no effect on either primary or secondary foci and infected thrombi in the circulation.

5. Differentiation has been made between "shower" and "massive" invasion of the blood-stream by bacteria.

6. Precautions and a method of administration of serum have been outlined.

7. The importance of surgical treatment of primary and secondary foci has been emphasized.

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STUDIES ON THE ACTIVITY OF THE LUMBAR SYMPATHETIC NERVOUS SYSTEM

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The investigations of Hunter and Royle[1] on the sympathetic nervous system have opened a relatively new field for surgical exploration. Pioneers have prospected on the influence of the lumbar sympathetics in such conditions as spastic paralysis; Raynaud's disease; thrombo-angiitis obliterans; Hirschsprung's disease; arthritis deformans; trophic ulcerations, etc. These patients have been selected as carefully as possible from the clinical symptoms of the disease.

An attempt had also been made to refine the diagnosis in the vascular disease group so that patients with marked vasospasm could be separated from the organic obliterative types without spasm. Brown[2] suggested the intravenous injection of a foreign protein (typhoid vaccine) in sufficient doses to produce a systemic rise in temperature of from 1 to 2° C. The changes in the surface temperature of the involved part compared to the general systemic reaction give an index of the vasodilatation and increased blood flow. In Raynaud's disease the surface temperature changes are striking; in thrombo-angiitis obliterans the changes are variable, depending on how extensive the spastic element enters the picture. This vasomotor reaction has proved quite useful as an indication of the probable value of an operative attack on the sympathetic nervous system. It is only fair to state, however, that the patients often are extremely uncomfortable following this test. There is frequently a violent chill with a fear of impending death; preëxisting pain may increase and various body aches may appear; the discomfort may become so marked that morphine is required; and the whole reaction may extend over a considerable time. It has been our experience that patients often refuse a second injection offered as treatment. Allen and Smithwick,[3] furthermore, have noted the development of thrombosis during the early stage of the reaction in arteriosclerotic individuals so that amputation was necessary in two instances.

The present studies represent an attempt to gain information in the vascular diseases with less discomfort and less disturbance to the endothelium of the vessels. Also the method developed affords information concerning the functional state of the innervation in other systems supplied by the lumbar sympathetic outflow.

Hirschsprung's disease.—Over-activity of the sympathetic nervous system has been assumed to be responsible for the conditions in which operative

intervention on this system is advocated. In Hirschsprung's disease, this is based on the success of this operation first reported by Wade and Royle.[4] No very definite information is available as to the exact mechanism of this stimulation. Judd and Adson[5] state that "it is impossible to determine whether this hyperactivity is due to an irritating lesion of the ganglia, of the post-ganglionic or the pre-ganglionic fibres, or is of central origin." They were of the opinion that it was probably of central origin.

In dealing with a case of this kind we thought that it would be desirable to get more information, if possible, both concerning the mechanism involved

FIG. 1.—Typical Hirschsprung's disease. Barium enema on admission. (Case I.)

and, as a practical point, for prognosis. All central impulses, including autonomic, can be blocked off chemically by the use of spinal anæsthesia. This offers a method for showing whether the sympathetic over-activity is of central origin; and if it is, it gives a test by which an accurate estimate may be of the value of removing this stimulation.

CASE No. 23255.—A seven-year-old boy was admitted to the Strong Memorial Hospital on September 7, 1929. He presented a typical example of congenital idiopathic dilatation of the colon. This was diagnosed from the characteristic history, the examination, and the röntgenogram (Fig. 1). All therapeutic attempts to produce normal evacuation of the bowels had been failures. He was often completely constipated for two or two and one-half weeks and at the end of such a period there might be nausea and vomiting of very foul material. He had never had a spontaneous movement in his

life. Repeated fluoroscopic examinations failed to reveal evidence of peristaltic action, and the whole colon appeared atonic. Four quarts of barium were introduced per rectum with no discomfort or painful sensations. He was able to expel only one quart of this mixture as his maximum effort (Fig. 2). Spinal anæsthesia was given. He

FIG. 2.—Maximum expulsion before spinal anæsthesia.
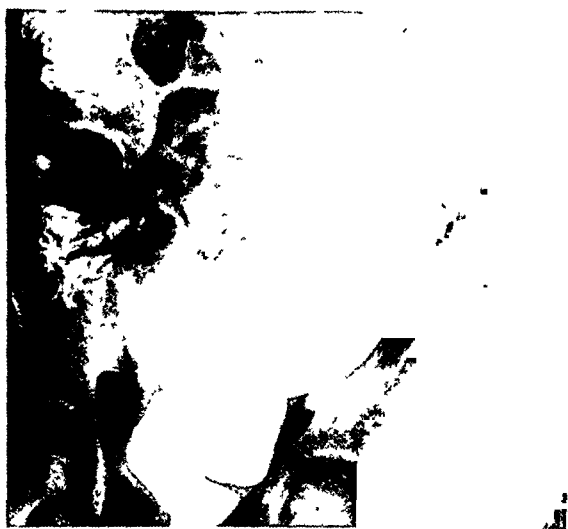
FIG. 3.—Twenty minutes after spinal anæsthesia. Ascending and transverse colon nearly empty. Sigmoid decidedly narrowed.

became extremely restless, complaining of what he called "itching in the stomach." This was followed by the expulsion of gas and barium. Peristaltic rushes came at irregular intervals of two or three minutes, lasting from thirty to sixty seconds. A bed pan was filled in the next fifteen minutes without difficulty. By this time the whole right colon had been practically emptied and the sigmoid was much narrowed (Fig. 3). A röntgenogram taken three and one-half hours after the spinal anæsthesia showed quite marked emptying of the large bowel (Fig. 4). Spinal anæsthesia had transformed the tremendous atonic bowel into one which had excellent expulsive power with peristaltic rushes. A bilateral lumbar sympathectomy was done on October 8, 1929. He had the first spontaneous bowel movement in his life on October 19, 1929. The bowel has been evacuated without medication, one to three times daily since this time. He had gained 1.6 kilos (three and one-half pounds) by January 10, 1930. He was having two regular formed stools daily. It required only two quarts of barium solution to completely fill the colon. Even this amount caused tremendous discomfort and desire to expel it.

FIG. 4.—Three and one-half hours after spinal anæsthesia.

The haustral markings were sharply defined. Expulsion of the barium was complete with no trace whatsoever in any portion of the colon (Figs. 5 and 6).

Thus, in this instance, it was possible to demonstrate that the over-activity of the sympathetic was under central influence; and an accurate prognosis could be made as to the probable effect of lumbar sympathectomy.

We were sufficiently encouraged by this experience to make use of spinal anæsthesia as a test in our next case of Hirschsprung's disease.

CASE No. 32554.—A five-year-old boy was admitted to the Strong Memorial Hospital on February 19, 1930. Here again we were dealing with a typical example of the disease. The history, the physical examination and the rontgenogram were quite characteristic. He frequently went for nine days without a movement. Ordinary cathartics and enemas were useless but some form of "patent tea" had been used with enemas successfully. On only two occasions during his life had there been a desire to go to stool; and there had never been a spontaneous evacuation. The large bowel held three and a quarter quarts of barium mixture, as the röntgenologist's report states, "an amount sufficient to fill the colons of two normal adults." There was no complaint and no evidence of peristalsis. The patient was asked to expel all that he could. After fifteen minutes of effort he had passed nothing. Spinal anæsthesia was then administered. Approximately ten minutes later sudden peristaltic rushes occurred with the expulsion of most of the colon's contents. A moderate amount of barium remained in the descending colon. The patient scratched at his abdomen and complained of "itching." The spinal anæsthesia had produced definite changes in the tone of the large bowel, which showed lessening in its dilatation, and evacuation of at least three-fourths
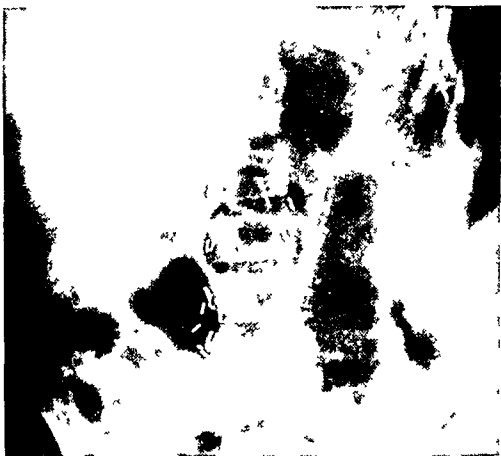
FIG 5 —Discomfort caused by half the amount of barium given without sensation before operation

FIG 6.—Complete voluntary expulsion of enema.

of its contents. We believe that this is evidence that lumbar sympathectomy will be effective in this case. The patient will probably be operated upon in the near future.

This experience with clinical cases of Hirschsprung's disease pointed to the desirability of further testing the results of spinal anæsthesia on the large bowel in experimental animals. Cats were selected as the animals of choice because previous investigators have commented on the lack of movements in the colon of the cat when the abdomen was open. Light ether anæsthesia was employed and a laparotomy performed. The colon remained inert and motionless in all cases examined except one that showed a little feeble peristalsis which quickly ceased entirely. This was in decided contrast to the activity of the small bowel. Even when the large bowel was distended by fecal material or artificially by fluid introduced through the ileo-colic junction, it remained inert and there was no evacuation. A local rhythmic contraction could be induced by a mechanical stimulus such as pinching or handling but no coördinated peristaltic action was observed. Spinal anæsthesia was then employed. In five to ten minutes, the large bowel

became very active. Contractions occurred in both the longitudinal and circular fibres with a resultant shortening of the whole segment and deep peristaltic waves. Peristalsis took place over the whole upper colon, contractions being rhythmic, and both ascending and descending in nature. There was a transformation from a toneless, flabby bowel to a moving, tense segment. No actual emptying of the colon took place under ordinary circumstances when it was not very full. But if the colon had been distended artificially (to simulate the conditions in Hirschsprung's disease) emptying was marked and rapid. This response was typical and it was observed in every animal studied. Also it was impossible to distend the colon with fluid when under the influence of spinal anæsthesia.

Removal of the central influences on both the sympathetic and parasympathetic terminals causes the intrinsic nervous mechanism of the bowel to function without inhibition. This result may be accomplished at operation by destroying the sympathetic nerve supply either by ramisection, by removing the lumbar ganglia, or by dividing the post-ganglionic fibres. Whether the activity of the bowel after such an operation is due to the function of the intrinsic nerve supply alone or is augmented by the parasympathetic tone will require further investigation. It is reasonable to suppose, however, that all central influences are abolished by the spinal anæsthesia block. This study has been fully reported elsewhere (Scott and Morton[6]).

Vascular diseases.—The response of the vessels of the lower extremities to spinal anæsthesia can be easily followed by measuring the surface temperatures.* The latter are determined after the feet have been exposed for some time at a temperature of about 22° to 23°, so that a base line can be obtained. Spinal anæsthesia is then given and the surface temperatures are recorded at intervals. We have found by this method that individuals with clinically normal blood-vessels may show one of two types of response. Most people literally show "cold feet" by actual temperature measurements, when they come to the operating room. The temperatures may be only slightly above 22° C. When spinal anæsthesia is given to them there is usually a sharp increase in the surface temperature of the feet until the rise is well over 30° C., at times to 35° C. This is the more common response. On the other hand, when there is a fever, or in the presence of a debilitating disease, the reaction may be only a very slight rise or even a prolonged slow fall. In these individuals the surface temperatures of the · feet are over 30° C. before the spinal anæsthesia is given. It is an indication that the vasodilatation is already acting at its maximum; or at least that there is no sympathetic vasoconstriction at the time of the examination. Patients with organic vascular disease such as endarteritis obliterans, in which vasospasm has no major part, show no change or a fall in surface temperature after

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* The surface temperature readings were made with a simplified compact instrument of the thermocouple type, developed under our direction by the Taylor Instrument Company, of Rochester, New York. (For description of this instrument see J.A.M.A., 1930, 94, 1987.)

spinal anæsthesia. Patients in whom there is organic vascular disease with an element of vasospasm as in thrombo-angiitis obliterans, show a moderate to marked rise in surface temperatures following spinal anæsthesia. After lumbar sympathectomy the surface temperatures of the feet usually record at a high level. Spinal anæsthesia has no effect on such surface temperatures unless some fibres have been overlooked. In the latter case there may be a feeble response. When a unilateral lumbar sympathectomy has been done, spinal anæsthesia may show a considerable difference between the sides, provided the unoperated side has some spastic vascular disease. When no disturbance of the vascular system is present, the difference between the two sides may be slight under ordinary conditions. It is usually possible, how-
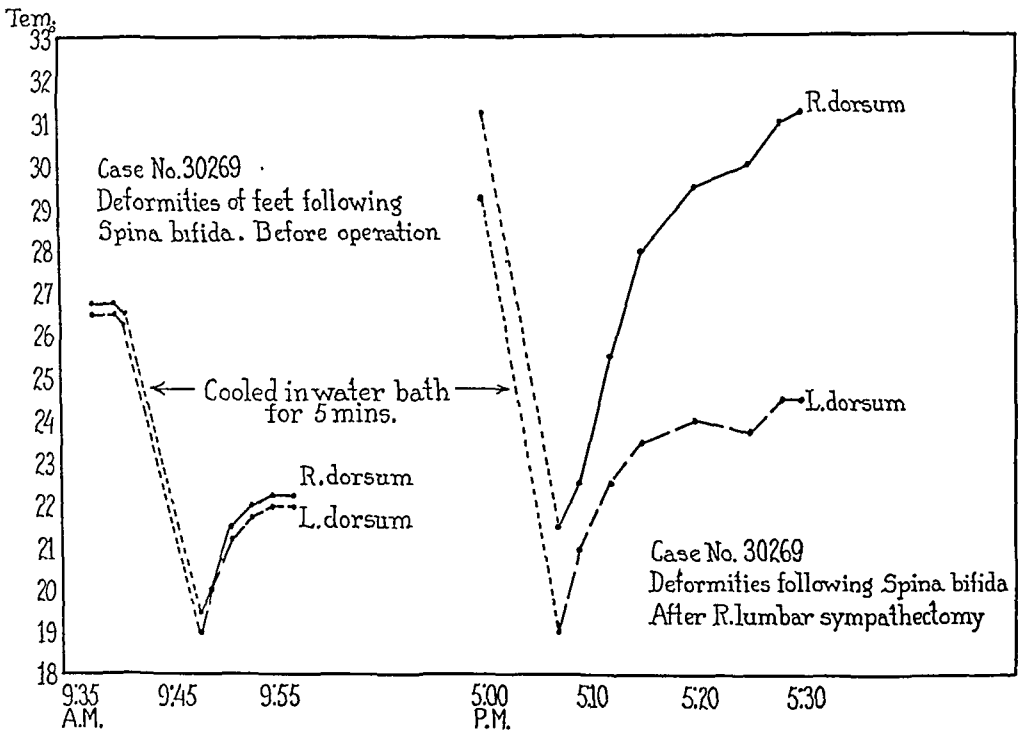
FIG. 7.—Test for vasomotor activity before and after sympathectomy in spina bifida.

ever, to bring out the contrast between the sympathectomized and the non-sympathectomized limbs. By artificially cooling both sides in a cold bath, the surface temperatures may be reduced to a low level. On being allowed to recover, the operated side responds with a quick sharp rise to its maximum. The unoperated side also reacts but the curve after the first two or three minutes is slow and prolonged. It requires a considerably longer time for the unoperated limb to reach its previous surface temperature (Fig. 7).

We believe that low spinal anæsthesia offers a safe test for the lumbar sympathetic effect on the vessels of the lower extremities. We regard it as a quicker, safer, more certain and more selective index of the probable effect of lumbar sympathectomy than the foreign protein reactions. The detailed study of these vasomotor reactions with charts has been reported elsewhere. The normal vasodilatation level, the occlusion index, and the vasoconstrictor

gradient have been defined and their significance discussed (Morton and Scott[7]).

Painful states of possible sympathetic origin.—Patients with painful amputation stumps are notoriously difficult to treat with uniform success. This is partly due to inadequately determining the exact cause of the pain. But even when a careful analysis has been made and the pain seems localized to the nerve trunk, to local vasomotor influence, or to the sympathetic nervous system, a small percentage of failures remains after any type of treatment. A recent experience with a case of this kind has convinced us that some of these patients have a true hysteria imposed on the local condition. Our patient had evidence pointing to involvement of the nerve trunk and possibly to a vasomotor neurosis. Operation for the correction of these conditions resulted in only temporary benefit. The question of a further operation, this time on the lumbar sympathetic trunk, was next considered but it was decided first to apply spinal anæsthesia as a test. This revealed that even complete section of the spinal cord would not have removed the consciousness of the painful impressions projected to the amputated limb. Now that the local conditions have been corrected, it seems that psychotherapy has a better chance for success in this case than any other treatment. This psychoneurotic type of patient may be responsible for the failures reported in the treatment of these conditions.[8] A brief summary of this case is presented here.

CASE No. 31637.—A fifty-year-old man was admitted to the Strong Memorial Hospital for the first time on February 10, 1930. He had had a crushing injury to the left leg on May 9, 1929, and when gangrene resulted an amputation had been done. He had begun to complain of pains across the instep and under the toes of the amputated foot shortly after the operation. The pains had been steady and continuous, not boring nor burning in character. Abscesses had formed in the stump. Drainage and reamputation had been done elsewhere. In spite of this he still felt the pains projected to the amputated foot. When first seen by us he had a small residual abscess in the stump, an adherent scar, a sensitive sharp bone end, and a painful sciatic nerve end-bulb. He was a nervous patient. His right foot was cold, blue and moist suggesting a sympathetic nerve disturbance. After careful study, a reamputation was done with resection of the nerve bulb, alcohol injection of the sciatic, and periarterial sympathectomy of the femoral artery. The patient was almost completely relieved of his painful sensations in the phantom limb till twelve days after operation. At that time he began to suffer with his foot again and soon complained of it as bitterly as before operation. Lumbar sympathectomy was at this time considered as a possible operation for relief but it was decided to test the effect of spinal anæsthesia on his pain. This was done on March 6, 1930. Although he obtained motor paralysis of the right lower limb and left thigh and complete sensory anæsthesia to about one inch below the nipple line, he still complained of pain in the left foot as severe as before the spinal anæsthesia. The diagnosis of psychoneurosis was made and he was referred to a psychiatrist for treatment.

Traumatic neurosis, arthritis, ulcer.—There is a heterogeneous group of conditions for which operations on the sympathetic system have been reported as sometimes producing brilliant results. This group includes such lesions as trophic ulcerations; traumatic œdemas; traumatic arthritis; arthritis

deformans; *etc.* So far, we have had too few cases of this group to allow us to make very definite statements and up to now have had to select such patients for operation empirically. We are confident, however, that it will be possible to develop selective functional tests so that some of these patients may be chosen for operation with assurance that success will follow. It has been assumed that there is a derangement of the normal vascular supply in the production or in the maintenance of these states. A sufficient number of such cases have been reported from several clinics to lend weight in certain of these cases to the hypothesis that there is a sympathetic over-activity. We have used spinal anæsthesia in this group, recognizing that the activity tested is merely vasomotor. Such evidence is at best indirect and not a direct test of the function in the system involved as was the case with the large bowel and the vascular diseases. In several of these cases there was definite clinical evidence of sympathetic over-activity manifested by coldness, cyanosis and increased perspiration in the involved extremity. Spinal anæsthesia completely abolished the clinical and temperature differences in the two legs. Still, we are by no means certain that the underlying condition in each case will be benefited by operation, as the reactions are in no sense selective for the functions of the joints, the lymphatics, or the general tissues of the extremity. So far as we can determine, they tell us about only the vasomotor activity. This factor can be controlled by operation. It is often quite difficult to determine what course of treatment should be chosen even when the sympathetic nervous system can be implicated. In a case of traumatic arthritis, for example, lumbar sympathectomy was seriously considered for some time when the symptoms were pronounced and improvement did not take place on conservative treatment. By patient waiting, however, all the trouble disappeared. This would have been a splendid result if lumbar sympathectomy had been done.

CASE No. 23456.—A fifty-seven-year-old man was admitted to the Strong Memorial Hospital on April 9, 1929. He entered because of a painful swollen right foot. He had noticed pain in his right foot three months before but it had not caused sufficient trouble to require medical attention. After driving across the continent to California, the pain increased but he still continued about his activities. Two weeks before admission the right foot became swollen. Examination was normal except for the right foot which was œdematous over the dorsum and toes. There was no localized tenderness. Active dorsiflexion was the most uncomfortable movement but there was very little pain either on active or passive motion. He had no fever and no foci of infection were demonstrated. Röntgenograms showed indistinct joint spaces about the small bones of the mid-foot. There was marked washing out of the calcium from the bones and some of the changes were thought to be destructive. He was discharged on April 11, 1929, with a diagnosis of traumatic arthritis. He was restricted in his activities, protected his foot as much as possible and had physiotherapy. There was a progressive increase in calcium loss from the bones as revealed by X-rays over the next six months. His condition was regarded by various consultants as tuberculosis, sarcoma, or some disorder on a neurological basis. Amputation was advised by a leading surgeon but was wisely refused by the patient and his physician. Lumbar sympathectomy was seriously considered but a further period of conservative treatment was recommended first. Improvement began about two months later and progress was steady. Calcium was

redeposited in the bones which resumed their normal röntgenographic outline. The joints showed no destruction. Function returned slowly to normal. This case is presented through the courtesy of Dr. T. B. Jones. It is our impression that sympathectomy would have hastened the return to normal. This case shows the possibilities of conservative treatment. The age of the patient and his economic status as well as the danger of permanent functional damage should be considered by the surgeon in deciding upon treatment.

In a case of traumatic œdema of the leg with decided clinical sympathetic symptoms, spinal anæsthesia abolished the coldness and excessive moisture of both feet. The local fibrous tumor in the region of the tendo Achillis was removed. We hope that this will bring about a clinical cure but the question of lumbar sympathectomy is naturally still unsettled.

CASE No. 32949.—A thirty-two-year-old man was admitted to the Strong Memorial Hospital on March 13, 1930. He was knocked down by a truck on September 17, 1929, and the rear wheel injured his right heel. There was laceration of the skin and exposure of the deeper structures with a painful bluish swelling of the whole foot. Röntgenograms showed no fractures. He was treated by physiotherapy but was unable to bear weight on the foot till late in January, 1930. One month later he could walk unsupported but there was persistent painful swelling about the ankle which caused great annoyance. On examination he showed a firm, slightly painful swelling alongside the medial edge of the Achilles tendon. Both feet were cold and moist but the coldness extended higher up the leg on the injured side. The veins of the right side were quite prominent and there were two dark brown patches over the right tibia, the residuum of an ecchymotic area. There was hyperæsthesia over the right ankle and heel. All movements of the foot were restricted, and the patient walked with a limp, bearing his weight on the outer side of the right foot and the toes but scarcely touching the heel to the ground. The right foot would become blue, swollen and œdematous after he had been on his feet for a short time. A mass of scar tissue was dissected free from the tendo Achillis on March 15, 1930. Spinal anæsthesia was used and both feet showed a striking rise in surface temperature becoming warm and dry. The condition will be carefully followed and unless improvement takes place, lumbar sympathectomy may be recommended. This case is presented through the courtesy of Dr. S. J. Stabins.

We are working our way cautiously with cases of chronic non-specific polyarthritis which show any clinical suggestion of vasomotor over-activity. We feel that all such cases at present are experimental studies and sympathectomy has been done only after every other therapy has failed. The patient is given to understand that the attempt is in the nature of an experiment as we have no specific test to be applied beforehand. In four cases of such arthritis, three of them have shown a well-marked vasoconstrictor activity which has been obliterated by spinal anæsthesia. We have no way of knowing at present whether this sympathetic activity is more continuous than it is in normal individuals.

It seems probable that there will be a field for lumbar sympathectomy in cases of spina bifida with sensory impairment in the lower extremities. In these cases there is undoubtedly disturbance on the vasomotor side. We have not desired to change the subarachnoid pressure relationships with spinal anæsthesia in them. We have had two experiences, however, which convince us that the removal of the lumbar sympathetic chain is valuable. In one case this was done to cure a trophic ulcer, and in the other to provide the best possible nutrition as a prophylaxis against ulceration. One of these

cases with unilateral operation gave us an opportunity to compare the two limbs. The recovery of the surface temperature after cooling by a cold bath was much more rapid on the sympathetomized side. (See Fig. 7.) These case reports are briefly presented here.

CASE No. 6326.—A twenty-year-old man was admitted to the Strong Memorial Hospital for the fifth time on January 28, 1930. His previous admissions were for operations to correct the deformities of bilateral talipes equino-varus resulting from a large, untreated spina bifida. There was also a cystitis due to internal sphincter paralysis; and a diverticulum of the penile portion of the urethra. There was loss of pain sensation alone in the distribution of the sacral third, fourth and fifth nerves. The present admission was subsequent to the development of an infected calloused area on the sole of the left foot. There was a hemolytic streptococcus infection over the dorsum of the foot which required incision and drainage. Inasmuch as the ulceration was present in an area of impaired sensation and had not improved for six months, it was looked upon as a trophic disturbance. Accordingly, on February 12, 1930, a left lumbar sympathectomy was done. Although there was evidence of infection and bone destruction in the distal end of the first phalanx of the fifth toe, the sympathectomy definitely increased the peripheral circulation and the swelling rapidly subsided. The ulcer was completely healed by March 14, 1930.

CASE No. 30269.—A four-year-old boy was admitted to the Strong Memorial Hospital on December 8, 1929. The child had a myelomeningocele which had been operated upon shortly after birth. He entered the hospital because of marked deformities of the feet. These consisted in an equino-varus on the right with a large reddened bursal development over the dorsum of the foot from faulty weight-bearing; and an equinus on the left. There was also a loss of painful sensation in the soles of the feet; and a constant overflow from the bladder. The feet when exposed were cold, clammy and blue. It was evident that attempts to hold the feet in corrected positions would be quite likely to result in ulcerations in these areas of impaired sensation. It was decided that since lumbar sympathectomy was the best treatment for trophic ulcerations on the feet, it should, therefore, be the best prophylaxis. As a preventive measure, right lumbar ganglionectomy was done on December 18, 1929, at the request of the orthopædic surgeon. There was a striking clinical improvement in the circulation, the foot on the operated side becoming pink, dry, and so much warmer than the opposite foot that it was obvious on palpation. Surface temperature readings showed the difference to be 2° C. on the dorsum of the foot. The orthopædic correction is now being carried out.

Discussion.—The advances in the surgery of the sympathetic nervous system, to date, have been made in an empirical fashion, the surgeon hoping that the operation he does will be of benefit to the patient. As yet, selective tests for its participation in the various clinical syndromes have been lacking. The nearest previous approach to a test for sympathetic over-activity is the intravenous injection of typhoid vaccine for its effect on the vascular system. In an endeavor to obtain a more selective reaction, it seemed to us that temporary paralysis of the sympathetic nerves was rational. By using spinal anæsthesia, we were able to study the large bowel and the peripheral vascular system of the lower extremities freed from sympathetic activity. It is thus possible to demonstrate whether operative interruption will be beneficial; and also how effective it will be. We are confident that the effect of spinal anæsthesia will yield this information both in Hirschsprung's disease and in vascular diseases of the lower extremity. Probably further simplification of

this method can be achieved. The effects of general anæsthetics on the peripheral temperatures have already been recorded by several investigators.[9, 10] There is a rise in the cutaneous surface temperature following ether and nitrous oxide anæsthesia. It is uncertain just how general anæsthetics produce their peripheral effects and consequently we have not reported them in this study, as we have desired first to establish the basic response to a known paralysis of the sympathetic innervation. We are now studying the availability of nitrous-oxide oxygen anæsthesia as a simplified procedure to measure sympathetic vasoconstriction in the extremities. Also, it is desirable to develop new reactions as selective tests in other diseases for which the sympathetic system is assumed to have a major rôle. Such a pre-operative determination should be the aim of all those who are doing this type of surgery.

CONCLUSIONS

1. An important step in advancing the surgery of the sympathetic nervous system is the development of methods to accurately predetermine the degree of its functional involvement in each case.

2. Such tests will permit the proper selection of cases and will indicate the probable outcome following operation in any individual case.

3. Spinal anæsthesia offers such a diagnostic test to estimate the participation of the lumbar sympathetic nervous system.

4. It is possible by this means to show temporarily over-activity of central origin.

5. The sympathetic element thus shown may, therefore, be permanently controlled by operation.

6. A functional test for Hirschsprung's disease is the effect of spinal anæsthesia on the motility and expulsive power of the large bowel as determined with a barium enema.

7. A functional test for vascular diseases of the lower extremity is the change in the surface temperatures of the feet following spinal anæsthesia. It is thus possible to demonstrate the proportionate amounts of organic obliteration and vasospasm. It is a safer, surer, quicker, and more selective test than the reaction to foreign protein.

8. No specific functional tests have been evolved for trophic ulcerations, traumatic arthritis and œdemas, non-specific polyarthritis and states of nervous origin as poliomyelitis, etc. This group requires further study. Vasoconstriction can be demonstrated in these conditions but its significance is not clear.

9. Spinal anæsthesia may be of great value in the differentiation of true pain of sympathetic origin from psychoneurosis.

10. Lumbar sympathetic ganglionectomy provides improved circulatory conditions in deformities of the lower extremities consequent on neurological lesions, as in cases of club foot due to spina bifida. It should be given consideration in the prophylaxis as well as in the treatment of trophic ulcerations.

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RECENT ADVANCES IN THE TREATMENT OF CIRCULATORY DISTURBANCES OF THE EXTREMITIES

RESULTS OBTAINED IN THE PERIPHERAL CIRCULATORY CLINIC OF THE MASSACHUSETTS GENERAL HOSPITAL

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In November, 1928, a special assignment was granted to a small group from the surgical staff at the Massachusetts General Hospital to study and treat circulatory diseases of the extremities. A special clinic was established in the out-patient department where ambulatory and follow-up cases are seen and treated each Saturday morning. Patients requiring hospital care are visited by the entire group once each week and their treatment supervised. The management of diabetics coming under this assignment has been admirably adjusted to the needs of the hospital by Dr. Leland S. McKittrick, of our group, and Dr. Roy Wheeler, of the Medical Service. Drs. J. C. White, R. H. Smithwick, and H. H. Faxon have worked out many of the details and carried out valuable research in this field. The advice of Dr. George S. Van Gorder, of the Orthopedic Service, concerning the adjustments of arch supports and shoes, has been of great value. The assistance of Dr. J. F. Kelly, in caring for the calluses and nails of these patients, has been helpful.

It was primarily our intention to devote the greater part of our effort to the study and care of cases with peripheral arterial disturbances and it is with these that we will deal chiefly in this résumé. It has been necessary, however, to devote a great deal of our time to the management of varicose veins, inasmuch as the injection method of treatment has recently created such a tremendous demand from these patients.

From December 1, 1928, to May 1, 1930, 763 new cases have come to the clinic with a total of 3650 visits. Five hundred and sixty-nine were cases of varicose veins; the remaining 194 patients suffered from some other form of circulatory disturbance. During this period of sixteen months we have treated 149 patients in the house with an average of thirty-two and four-fifths hospital days. With a review of the work to date and our previous experience, we wish to present our conception of the proper management of such cases as it stands today.

Varicose veins.—A detailed report of our experience with the injection method of treatment in these cases will shortly be made by one of the clinic.[1] Here suffice it to say that in dealing with a large number of patients, seen usually once a week, the repeated injection at intervals has been more satisfactory than the multiple massive injections advocated by some. The solution found best suited to our needs is quinine and urethane. On the whole, the results have been amazingly successful, and if the internal saph-

enous and other large superficial radicals in the thigh are sclerosed as well as those below the knee, we have reason to believe that the majority of cases will remain relieved. We have already seen some recurrences in patients whose treatment was not carried above the knee. We have had a few excessive reactions from small doses of solution, in a few instances, sufficient to confine the patient to bed for a short period of time. We have also had a few troublesome sloughs when the solution was given so that the fluid escaped or was inadvertantly injected into the surrounding tissue. In one case one cubic centimetre of quinine and urethane given as a second injection low in the leg produced a thrombosis of the entire saphenous with symptoms and signs of an acute phlebitis. This patient was confined to bed for ten weeks during which period she had three typical pulmonary emboli.

LESIONS OF THE EXTREMITIES DUE TO ARTERIAL INTERFERENCE

General considerations.—Etiologically, most circulatory disorders of the extremities remain a mystery. The pathology, however, is quite well understood. The majority of cases that present themselves for treatment have many characteristics in common, regardless of their age, sex, nationality or type of arterial obliteration—such symptoms as pain, intermittent claudication, insomnia and a lowered tolerance for cold, may be complained of by all. Extremities will blanch on elevation and become cyanotic on dependency. The surface temperature is lowered to a degree measureable by touch, and the peripheral arteries are prone to pulsate feebly or not at all. Often there is a beginning ulceration, trophic disturbance, or gangrene. Due to the upright position of man and the consequent greater strain on the circulation of the feet and legs, the majority of these disorders involve the lower extremities. Many patients diagnose their own condition as flat feet, and seek relief through arch supports and special shoes. That these disorders should have symptoms and signs in common is easily understood when one considers that there is in all of them a deficient blood supply. Although this makes the diagnosis difficult and in border-line cases a cause for argument, it does help in the general treatment of such cases.

Classification.—We believe that simplicity is essential, and therefore classify these diseases into two main groups: first, those with mechanical arterial obliteration; and secondly, those dependent upon vasomotor imbalance. Under the former we have true arteriosclerosis of the senile type and that associated with the comparatively younger diabetic, also, the young and middle-aged individual with progressive obliteration without calcification, the majority of whom have thrombo-angiitis obliterans (Buerger's disease), and a few cases in this group with disease of the middle coat of the artery belonging to the type of arteriosclerosis described by Mönckeberg. In the second, or vasomotor, group there is a great variation as to the extent of the process, from a mild form of multiple phase color change noticeable only on exposure to cold, to a progressive trophic disturbance leading to gangrene of the tips of digits and a more generalized scleroderma. The

former may be referred to as phasic and the latter as constant, the term Raynaud's disease being loosely applied to all cases of vasomotor imbalance. It is important to note that in many cases of obliterative arterial disease that a definite but variable vasomotor influence may be superimposed.

Examination and history of the patient.—It is important to take into consideration the duration of symptoms; the extent and period of disability; the type of work; injury or previous inflammatory processes such as phlebitis; the amount of generalized arteriosclerosis; stability of the nervous system and habits—any or all of these may throw considerable light on the diagnosis and prognosis. During the examination it is best to have all the extremities fully exposed. Although only one may be sufficiently troublesome for complaint, the other extremities may be involved to a lesser degree; at any rate, a better estimation as to the extent of the process can be ascertained by a comparison of the two sides. Inspection may reveal swelling, cyanosis, rubor or pallor. Touch gives an idea as to surface temperature. Palpation of the peripheral vessels is most important. The dorsalis pedis, posterior tibial and popliteal arteries should be taken into consideration as to the approximate volume of blood flow and the texture of the vessels. If the popliteal is absent, it is well to follow the femoral from Scarpa's triangle down as far as possible through Hunter's canal. The legs should then be elevated to forty-five degrees and the rapidity of blanching observed. Although a comparatively normal foot will become more pale on elevation, the cadaveric hue of the extremity in cases of arterial insufficiency in this position is unmistakable. A recent article by Samuels[2] suggests that in making this test the patient be asked to flex and extend his toes, as this brings out the pallor more strikingly as the motion hastens the blood out of the foot. Following this, the extremities should be lowered and the amount of time necessary to bring about rubor and cyanosis noted. The extremities that become cadaveric in less than two minutes of elevation or become cyanotic on dependency in a like time are deficient in circulation, regardless of the pulsation in the peripheral arteries. More detailed methods of examination can be done in the hospital, such as actual measurement of the surface temperature by the thermo-couple; estimation of the blood flow with the Pachon oscillometer; the number of steps at a given rate per minute to bring on intermittent claudication; the effect of foreign protein on the surface temperature and relief of symptoms; a diagnostic novocaine block to determine the vasomotor element, *etc.* All of these tests are of value in the diagnosis and the outline of treatment.

Differential diagnosis.—Here we often have our difficulties and not infrequently our first impression is incorrect. Some are border-line cases and occasionally remain as such, a definite diagnosis being impossible until the microscopical examination of a pathological specimen is made. On the other hand, many are clear-cut or have an overwhelming majority of symptoms and signs classifying them into one of the few groups that we recognize. We feel that many of the conditions such as erythromelalgia, acrocyanosis,

trophoneurosis, *etc.*, are probably not entities in themselves but simply represents a phase in disorders more readily understood. That there can be an element of sclerosis in cases of thrombo-angiitis obliterans seems reasonable when we consider that some of these patients may have had the disease for twenty years and have reached an age compatible with arteriosclerosis before symptoms of sufficient severity to bring about incapacity have overtaken them. That there is a definite vasomotor element in many of these cases there can be little doubt, and occasionally this phase almost outweighs the true underlying condition. This is particularly true when ulceration is pres-

Chart of differential diagnosis based on our cases of arterial disturbances of the extremities. There are necessarily exceptions to the rule

	Vasomotor disturbances	Thrombo-angiitis obliterans	Mönckeberg's arteriosclerosis	Senile arteriosclerosis
Average Age	30	40	50	60
Sex	Female	Male	Male	Both
Nationality	All	Hebrew	All	All
Duration of Symptoms	Years	Years	Months	Months
Extremity	Upper	Lower	Lower	Lower
Symmetry	Bilateral	One side at a time	Unilateral	Unilateral
Gangrene	Late	Late	Early	Early
Pulsating Vessels	Normal	None	None	Faint or None
Vessels by X-ray	No	No	No	Yes
Response to Foreign Protein	Marked	Marked	Slight	Slight
Response to Novocaine Block	Rapid and Marked	Slow and Mild	To be determined	Slight
Development Collateral Circulation	None	Good	Slight	Fair

ent. Whether the increase in pain caused by the exposed nerve endings stimulates the vasoconstrictor fibres; the discomfort which forces the patient to assume injurious positions such as holding the foot down over the side of the bed while resting; the lack of sleep, food and drink, or the abnormal increase in the use of tobacco brings about a vasomotor imbalance, is simply a matter of conjecture. It seems evident in a large number of our cases that any or all of these factors may influence the circulation through the sympathetic nervous system.

Treatment.—General considerations. The following routine measures are applicable to nearly all of these cases entering the hospital.

1. Rest in bed with feet and legs covered by a large cradle heated with electric lights.

2. A Balkan frame attached to the bed to aid the patient in moving about and to encourage exercise of the upper extremities and trunk.

3. Fluids up to four quarts a day, plus a liberal diet.

4. Careful daily hygiene for the feet; *i.e.* pressure points, particularly the heels, protected by a pillow under the legs. Lanolin applied to callouses and fissures, careful dressing of ulcerations, mild antiseptic bathing solution to the skin, and care of the nails and callouses by the chiropodist.

5. Buerger's postural exercises[3] as soon as the patient is adjusted to his surroundings.

A detailed description of our modification of these exercises is given in the following paragraph.

The first position should last theoretically as long as is necessary to blanch
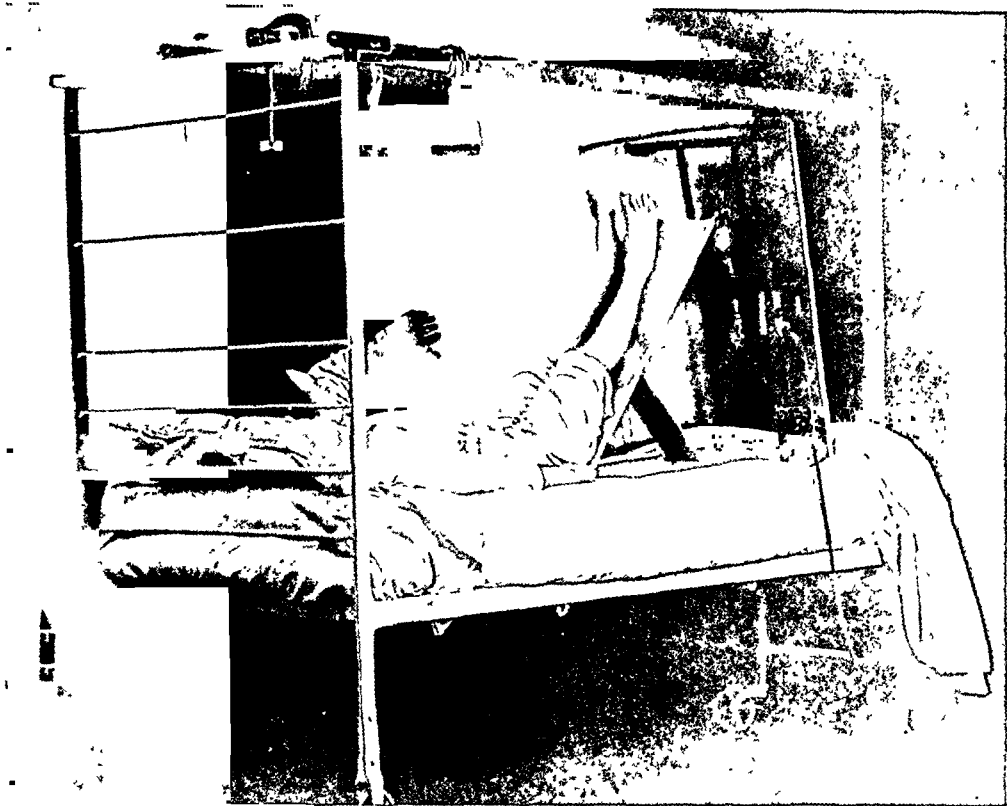
Fig. 1.—Postural exercises: Position 1—duration two minutes. Note Balkan frame, "Buerger board" (McKittrick and Root),[4] heated cradle, and accurate timing.

the extremity. This varies considerably, but two minutes of elevation at 45° is usually sufficient. (Fig. 1.) The second position is carried out by the patient sitting on the side of the bed with the feet hanging down. During this phase, which should also last two minutes, the patient should systematically dorsiflex and extend the feet, then invert and evert them, then flex and extend the toes. (Fig. 2.) The third position is carried out with the patient lying flat in bed with the feet either under the electric cradle or, better still, with the feet on an electric pad and covered with a light warm blanket, and should last five minutes. (Fig. 3.) The three positions consist of a cycle and there should be from three to six cycles in a séance, with from two to four séances a day. The exercises should be carried out with accuracy, a timepiece at the bedside or in the patient's hand being essential.

The importance of these postural changes cannot be overestimated, as these alone probably do more to establish an adequate collateral circulation and maintain some motion and strength in the muscles and ligaments of the feet than all other measures.

It is interesting to note the large number of patients admitted to the hospital who have suffered so much pain that rest, nutrition and body fluids have been disturbed. Many of them, without sleep for weeks, become comfortable on these routine hospital measures alone. This is so striking, particularly in the arteriosclerotic group, that we have been very careful about

Fig 2 —Postural exercises   Position 2—duration two to three minutes   Note the various active motions carried out in this position   A definite pause with relaxation is advocated between two and three and between four and five

crediting improvement to other therapeutic measures which have received more or less recognition in other clinics, as well as our own. For this reason, no specific treatment is given the average case until an estimation of the benefit obtained from general measures is established. In other words, it is essential to await the improvement brought about by rest, fluids, nourishment, hygiene, exercises and routine hospital care before instituting any special form of therapy. Also, this delay is frequently necessary to form a true opinion as to the diagnosis and the type of treatment best suited to each individual case.

Special treatment.—Our experience with some of the various forms of special treatment advocated in other clinics has been somewhat limited, owing to the fact that they have not been applied to a sufficient number of cases to warrant more than an impression as to their adequacy. These include:

1. Ligation of the main artery (Lewis).[5]
2. Ligation of the main vein (Oppel,[6] Holman,[7] Morton,[8] Van Gorder.[9])
3. Periarterial alcohol injection (McClintic).[10]
4. Repeated intravenous sodium citrate solution.
5. Large quantities of Ringer's solution by duodenal tube.

All of these methods have had some trial in our clinic but have failed in the few cases in which they were used to give the desired results. Perhaps the

FIG. 3.—Postural exercises: Position 3—duration five minutes. Note electric pad and soft blanket.

fault is our own in that the cases treated were not well selected. We feel, however, that other therapeutic measures have been more valuable in our hands.

Our experience with some of the other forms of specific treatment has been sufficient to warrant an opinion as to their value. Among these are the following:

1. *Periarterial sympathectomy* (Leriche) was given a trial in twenty-one cases of varying types.[11, 12] No cases of true arterial obliteration were improved for a sufficient number of days to make the procedure worth while. One case of vasomotor disturbance following injury, probably a trophoneurosis (Leriche) was relieved of pain for nearly a year. With this background, it is difficult to be enthusiastic over the possibilities of periarterial sympathectomy or periarterial alcohol injection. That these procedures do

elevate the surface temperature and, in some cases, relieve pain for a short time, is certain, but these reactions are fleeting and can be accomplished by much simpler methods.

2. *Non-specific foreign protein* (typhoid vaccine intravenously).—Our experience with this form of treatment is still increasing and the results justify a continuation of its use in certain types of cases. Its use as a prognostic procedure as advocated by Brown,[13] is helpful, and its therapeutic value became evident to us while estimating the amount of vasomotor element in a case of bilateral gangrene of the fingers.[14, 15] There is some danger in its promiscuous use and we have reported the possibilities of producing a thrombosis if it is given carelessly, particularly in patients with advanced arterio-
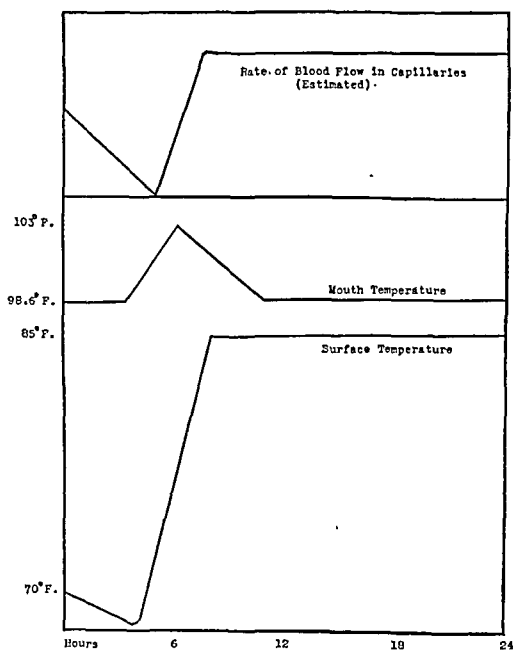
FIG. 4.—Non-specific protein reaction—(25 million organisms, mixed typhoid vaccine intravenously). Note slowing of capillary flow and decrease in surface temperature in early stage—which should be counteracted by preheating the extremities.[16]
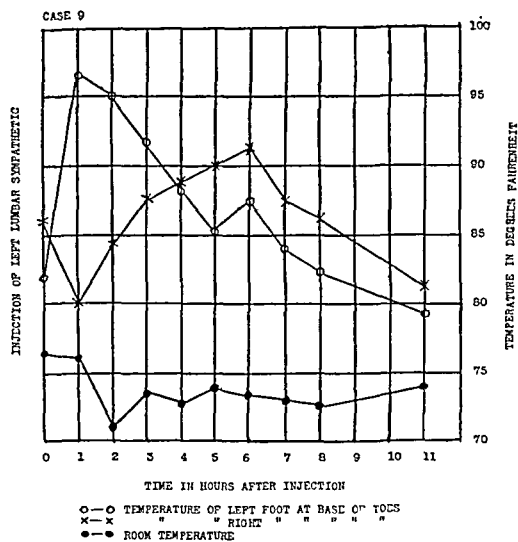
FIG. 5.—Chart illustrating typical temperature changes in novocain block of the left sympathetic trunk. J. C. White.[18]

sclerosis.[16] We have not been cognizant of any harm from it when properly used. When typhoid vaccine is given intravenously there is a characteristic reaction. (Fig. 4.) The peripheral circulation becomes slower during the first hour and associated with it there is a decrease in surface temperature and a generalized chill. As the mouth temperature reaches its peak, three to six degrees above normal level, the circulation in the peripheral vessels becomes speeded up to a degree far greater than it was originally. Associated with this phase is a rise in peripheral surface temperature equal approximately to three degrees (Fahrenheit) to each degree of mouth temperature elevation. This elevation of the surface temperature is maintained for several days after the mouth temperature has returned to normal. We have attributed the relief from pain and the improvement in the ulcerations to this increase in surface temperature which we have thought was brought

about by the action of foreign protein on the sympathetic nervous system. That there may be another and so far unexplained action of foreign protein seems possible, as illustrated by the following case:

A young man suffering from thrombo-angiitis obliterans in the right lower extremity was relieved of pain and impending gangrene by this method during a four months' stay in the hospital three years ago. Recently there has been a recurrence of the disease in the other leg. We obliterated the sympathetic influence by lumbar sympathetic neurectomy and the surface temperature of his foot has remained elevated to his maximum. In spite of this, his pain was more severe after the ganglionectomy and was relieved by the typhoid vaccine intravenously. This reaction is difficult to explain, inasmuch as the surface temperature could not be further raised beyond the mouth elevation. The possibility of a psychic factor cannot be overlooked. Ganglionectomy was done during a crescendo in the course of the disease. The increase of surface temperature seemed to hasten the development of gangrene in the tips of two toes.

We have used ganglionectomy in only three other cases of thrombo-angiitis obliterans and in these cases also, the healing of ulceration was extremely slow and in one case not influenced at all, in spite of the usual elevation of surface temperature to normal or more than normal.

In using typhoid vaccine intravenously we recommend the following technic and precautions: It should not be used in arteriosclerosis of a marked degree. It should never be given any patient without a preliminary heating of the extremities by means of electric pads, hot-water bottles and blankets at least one-half hour before giving the vaccines.[16] Dr. Frank Fremont-Smith[17] has shown that if this is done there is sufficient heat in the extremities to counteract the chilling process and consequent slowing of the blood-stream in the capillaries which otherwise occurs in the first phase of the reaction. If this precaution is taken we believe that thrombosis in the peripheral arteries will not occur. The first dose should be a small one, preferably about twenty-five million organisms of the mixed vaccine. If it is tolerated well, but the desired rise in mouth temperature to 103° F. does

	Vasomotor disease (Raynaud)	Thrombo-angiitis obliterans	Arteriosclerosis with and without diabetes	Totals
Number of Cases Treated	10	24	7	41
Average Age	25	40	60	
Average Duration Symptoms (Years)	2.9	4.4	0.4	
Number With Complete Disability	3	18	7	28
Minor Amputation Necessary	1	6	1	8
Major Amputation Necessary	0	3	4	7
Average Number of Treatments	3	9	8	
Average Duration of Treatments (Months)	5	8	4	
Improved	9	17	4	30
Not Improved	1	7	3	11
Complete Disability Now Including Cases c Major Amputations (after treatment)	1	6	4	11

A composite table showing the results of forty-one patients treated by non-specific foreign protein only. No other patients in this group have come to major amputations but three cases of thrombo-angiitis obliterans have returned with the disease in other extremities. These have also responded to treatment.

not occur, the next dose can be increased accordingly. It is important to be sure that the vaccine gets into and not around the vein. It should be given slowly. It is not necessary to increase the dose each time, as the same dose will produce the same reaction in the same individual indefinitely, if given properly and not more often than once in seven days. Patients should not be treated in the office or the out-patient department but should be in the hospital for at least twenty-four hours following the injection. The headache can usually be controlled by aspirin if given before the reaction begins. Opiates are occasionally necessary. Many patients who come in more or less regularly do not require any sedative.

As far as treatment is concerned, non-specific foreign protein still has its uses, although some cases respond better to other methods, as will be shown later. Although we still use it as a prognostic test to determine the effect of a surgical attack on the sympathetic nervous system, we believe that Dr. J. C. White[18] has given us a more accurate method of estimation by his novocaine block. He has found that novocaine injected into the main nerve, or the sympathetic ganglia or into the spinal canal, gives a temporary elevation of surface temperature in the extremity influenced, identical with that of ganglionectomy. Not infrequently the test may be made with spinal anæsthesia. If the desired rise in surface temperature is obtained, ganglionectomy may be carried out under the same anæsthetic. If the reaction is not adequate in spite of good anæsthesia, an amputation may be done under the same anæsthetic. We believe that the accuracy of this test and its simplicity makes it more valuable than any other yet devised. (Fig. 5.)

Alcohol injection of peripheral nerves.—Several years ago Silbert[19] advocated alcohol injection of peripheral nerves at the level of the malleoli for relief of pain in thrombo-angiitis obliterans. We tried this method in 1923 and found that wounds would not heal at this level, and therefore gave up the procedure. In the summer of 1928 we saw a patient with arteriosclerotic gangrene in his one remaining foot, who had received an alcohol injection in part of the sciatic nerve, seven months previously in another city. This was associated with toe drop and a certain amount of loss in muscle action. The painless gangrene, however, made an impression on us, as we watched a collateral circulation develop, to a point allowing weight-bearing four months later. This patient has since regained motion in the foot, although it took about eighteen months for the nerve to regenerate. His foot is useful and painless today, in spite of the loss of parts of three toes and the extra burden thrown upon it by the artificial leg worn on the opposite side. Smithwick and White[20] have developed a method of isolating and injecting the sensory nerves in the leg in such a manner as to produce anæsthesia of the foot without disturbing any of the muscular elements except the intrinsic muscles of the foot. We are so impressed with the value of this method of treatment that we feel it to be a distinct contribution to the management of these cases. The relief of pain is worth while, but there are other factors

which indicate its true importance. Dressings on these painful ulcerations were almost impossible from a surgical point of view. Exercises were not well borne on account of the increase in pain in the extreme positions. Rest was disturbed as well as nutrition and body fluids. When the pain is relieved, all these factors are eliminated and progress is usually rapid. In addition to this, we have noted that there is an increase in surface temperature, sometimes not as marked as that following novocaine block at a higher level, or when typhoid vaccine is given intravenously, but a distinct rise, showing, we believe, that the pain from the ulceration may act on the sympathetics or that there is some vasomotor influence at this low level through the sensory nerves themselves.

Alcohol Injection of Peripheral Nerves for Relief of Pain
December 1, 1929

Middle-aged (thrombo-angiitis and Mönckeberg)—9 cases
Average Age about 40

	No. Cases	Good Result	Major Amputation
Popliteal Pulsation +...............	3	3	0
Popliteal Pulsation —...............	6	4	2
	—	—	—
	9	7	2

Senile Arteriosclerosis...................... 7 cases

Average Age about 70

	No. Cases	Good Result	Major Amputation
Popliteal Pulsation +...............	3	2	1
Popliteal Pulsation —...............	4	1	3
	—	—	—
	7	3	4

Total Cases—16   Relieved—10 (62.5%)

Observing our cases it seems safe to anæsthetize any foot in the presence of a palpable popliteal artery. The alcohol should not be spilled in the tissues around the nerve, and care must be exercised to avoid trauma to accompanying vessels. About one centimetre of the nerve should be thoroughly infiltrated with the alcohol. In rare cases there will be disappointing results. in that the numbness and tingling in the foot, as the patient walks, will be complained of more bitterly than the symptoms for which the treatment was instituted. This was true in an arteriosclerotic with pulsating vessels and erythromelalgia. We have expected and looked for trophic ulcers following this treatment and have, up to date, two such lesions in our clinic. This may be avoided if proper protection from sponge rubber arch supports and properly fitting shoes are furnished. The nerve regenerates in a variable length of time, dependent upon the amount infiltrated, usually not early enough to interfere with the healing of ulceration and the establishment of an adequate collateral circulation.

Ganglionectomy (sympathetic neurectomy).—Following the visit of Royle and Hunter to this country several years ago, their technic of ramisection for spastic paraplegia was used in operating on a certain number of cases in this vicinity. Dr. W. J. Mixter called my attention to the striking increase in surface temperature of the foot on the operated side in one of these patients, five years ago. About this time Adson and Brown[21] published their results on a case of Raynaud's disease and later reported five cases of thrombo-angiitis obliterans, four of whom had been relieved by lumbar ganglionectomy. This was followed by further researches on their part, developing a technic which was successful on the upper extremity as well.[22] We have found this procedure amazingly successful in true vasomotor disorders. Our limited experience with the procedure in thrombo-angiitis obliterans, as shown above, is not so convincing. However, it is an extremely valuable contribution and undoubtedly we can expect *more* from it than from periarterial sympathectomy, and in the vasomotor group *more* than from non-specific foreign protein.

We advocate operation on one upper extremity at a time, as there is some danger of injury to the pleura; also, these wounds are prone to have a dead space difficult to close, and hæmatoma may develop. Bilateral lumbar ganglionectomy can usually be safely carried out and as the approach is through the abdomen, there will probably be less risk in doing both sides at one stage than to make two procedures of it. In the upper extremity the first and second dorsal ganglia and intervening trunk are removed. In the lower extremity the third, fourth, and fifth lumbar ganglia (the latter two being together) and the intervening trunk are excised. These are approached by rolling the cæcum toward the mid-line on the right, and the sigmoid in on the left. The ganglia lie closely adherent to the vertebra and are never reflected with the fat and connective tissue over them. The dorsal ganglionic chain may be reflected with the pleura but usually remains in contact with the vertebral column.

Sympathetic Ganglionectomies—1929

| | Upper | | Lower | | | |
| | Bi- | Uni- | Bi- | Uni- | Total | |
Disease	lateral	lateral	lateral	lateral	Sides	Results
Vasomotor (Raynaud's)	1	1	3	–	9	All Excellent
Thrombo-angiitis Obliterans. .	0	–	1	1	3	Doubtful
Polio—With Vasomotor	0	–	1	3	5	Doubtful
Atrophic Arthritis	–	2	–	–	2	Improved
Trophic Ulcer	–	–	–	1	1	Improved
Angina Pectoris	3					
Spastic Paraplegia	1					
Tabetic Crisis	1					
Erethema Induratum	1 Bilateral					

Total Patients—22   Total Ganglionectomies—29

Some of these cases have been operated upon by Dr. W. J. Mixter of the Neurosurgical Service.

Lumbar sympathetic neurectomy in the presence of an open ulceration may be followed by disastrous results, inasmuch as a virulent streptococcus may be dormant in such a lesion. In one case, a boy of eighteen, with marked vasomotor changes in all extremities and an ulceration above the internal malleolus that had resisted all other therapy, death occurred forty-eight hours following lumbar sympathetic neurectomy, this being our only fatality in thirty patients, representing over forty ganglionectomies to date. Streptococcus viridens was recovered from the operative field and from the heart blood at autopsy. We now culture all such lesions with great care before subjecting these patients to any radical operation. It is our belief that the lymphatics in the neighborhood of the sympathetic nervous system supplying the lower extremity may harbor virulent organisms which can easily be set free by the operative procedure.

Restoration of function.—It may appear presumptuous to suggest that care should be used in getting these patients back on their feet. We have seen nothing in the literature along these lines, and one may assume that the patients themselves should know their limits of safety. Many of these patients, however, are of low intelligence either through age, or inheritance. We also find that our house-officers have little or no idea of the proper reëstablishment of a patient's normal activities. When the time comes for the patients to begin getting about, after they have been in bed for several weeks, we limit their walking, at first, to one minute out of the hour. The remainder of the time is spent with the legs elevated to a horizontal. If this is well tolerated, it is gradually increased and the patient not discharged until he can walk for five minutes at a time without cyanosis and swelling. Patients with amputations whose conditions warrant a prosthesis are fitted with temporary appliances and taught to use them before leaving the hospital. We have seen cases who have lost one leg return within two weeks with symptoms in the remaining leg that led to gangrene and amputation simply because proper instructions as to gradual return to function were either carelessly explained or were unheeded. If routine measures are used along these lines, many difficulties in rehabilitation will be solved.

SUMMARY AND CONCLUSIONS

Cases with mild symptoms may carry on for an indefinite period by occasional advice in the out-patient department concerning rest, hygiene, care of the feet, proper protection with lamb's wool and woolen stockings, and exercises to be done at home. A suitable ambulatory case of vasomotor disorder or thrombo-angiitis obliterans may spend twenty-four hours in the Emergency Ward occasionally, at which time a protein shock with typhoid vaccine intravenously may be given.

Those cases of sufficient severity to cause complete disability, as well as those who need constant observation, are treated in the hospital. They are given any emergency attention necessary and are started on the routine measures of rest, heat, hygiene, fluids, food and exercises. After stabiliza-

tion, specific treatment is instituted according to the condition. Advancing infection is drained, and advancing lymphangiitis amputated. Non-specific foreign protein is tried in thrombo-angiitis obliterans, peripheral nerve alcohol injection in cases of intractable pain, and sympathetic ganglionectomy carried out in advanced vasomotor disorders.

In chronic cases an individual time limit is set and if improvement is not evident in a given time (one to eight weeks, depending upon the condition and contributory factors), more radical measures are adopted. If a person with a hopeless extremity which has remained at a standstill or definitely grown worse in spite of treatment, refuses amputation, then through the Social Service proper disposal is arranged, with all the helpful advice for comfort that we can give them.

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DISCUSSION: DOCTOR JOHN J. MORTON, of Rochester, N. Y., said that at the University of Rochester they had been developing tests by which it is possible to differentiate the relative proportions of obliteration and spasm in cases of peripheral vascular disease. Surface temperature readings were made with a thermo-couple on the exposed soles and toes of individuals with clinically normal blood vessels. These patients were about to be operated upon for some general surgical condition not related to the vascular system. When spinal anæsthesia was given, all nervous impulses to the feet were abolished and the normal vessels were released from sympathetic vasoconstriction effects. In a group of twenty-two patients of this type it was observed that before anæsthesia, there was a definite vasoconstrictor gradient, the surface temperature readings recording lower from a level just below the knee until the lowest temperatures were reached on the toes. Spinal anæsthesia abolished these differences in surface temperature readings and within a short time all surface temperatures had reached a considerably higher level. There was only a slight variation in the upper and lower limits of these higher surface temperature readings. We think that these readings under spinal anæsthesia represent the maximum vasodilatation possible and we refer to them as the "normal vasodilatation level." The only exceptions so far observed by us in patients with normal vessels were in cases of fever where the normal vasodilatation was already attained; and in cases of advanced carcinoma. In these latter patients there was a higher than normal surface temperature reading at the start and the surface temperature readings dropped lower after spinal anæsthesia.

The normal vasodilatation level having been established, it is possible in case of a peripheral vascular disease to record the surface temperature readings after spinal anæsthesia and to thus see how nearly the readings come to the normal level. The difference between the normal level and the level reached in the diseased limb represents the degree of obliteration—"obliteration index."

Lantern slides were shown illustrating the normal vasoconstrictor gradient; the normal vasodilatation level; and the obliteration index as determined in patients with peripheral vascular disease.

After lumbar sympathectomy the vasoconstrictor effect is completely removed and the surface temperature readings are consistently and uniformly maintained. Spinal anæsthesia has no effect on the surface temperature of such a limb unless some sympathetic fibres have been overlooked at operation. When a unilateral operation has been performed this difference between the operated and unoperated limbs shows strikingly. It is also possible to show in such individuals that after cooling the surface temperature recovers much more quickly on the sympathectomized side than on the side with the intact sympathetic nerve supply. Lantern slides were shown to illustrate these points.

By these methods the relative degrees of sympathetic vasoconstriction and organic obliteration can be determined in any case of peripheral vascular disease. We are continuing our studies to develop simplification of the methods. The Taylor Instrument Company of Rochester has helped us in making a simplified form of surface temperature thermometer for this work. It is here in case anyone wishes to see it.

Dr. W. J. Mixter (Boston) : said that the development of the circulatory clinic at the Massachusetts General Hospital has not only paralleled some of the neurological work there but Doctor Allen and he had worked together on some of these problems. The circulatory clinic at the Hospital has shown its value not only in the handling of the cases treated by injection of varicose veins but in many other ways. These attacks on the sympathetic nervous system in circulatory diseases offers a field which is going to develop more and more as time goes on.

Dr. Arthur W. Allen added that the personnel of the circulatory clinic consists of five men from the surgical service who are either interested in the subject or show signs of possible research in this field, one member from the medical service who is particularly interested in diabetes, a representative of the orthopedic service, and a chiropodist. It is essential to have complete coöperation of the men on this assignment as well as the entire hospital staff.

GENERAL SURGICAL CONTRIBUTIONS

NOT PRESENTED BEFORE THE AMERICAN SURGICAL ASSOCIATION

THE RÖNTGEN DIAGNOSIS OF ILEUS

By Alton Ochsner, M.D., and Amedee Granger, M.D.

OF NEW ORLEANS, LA.

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THE early diagnosis of ileus is of utmost importance in order that proper therapy might be instituted before marked changes have occurred in the intestinal wall or a severe toxæmia has developed. The necessity of early
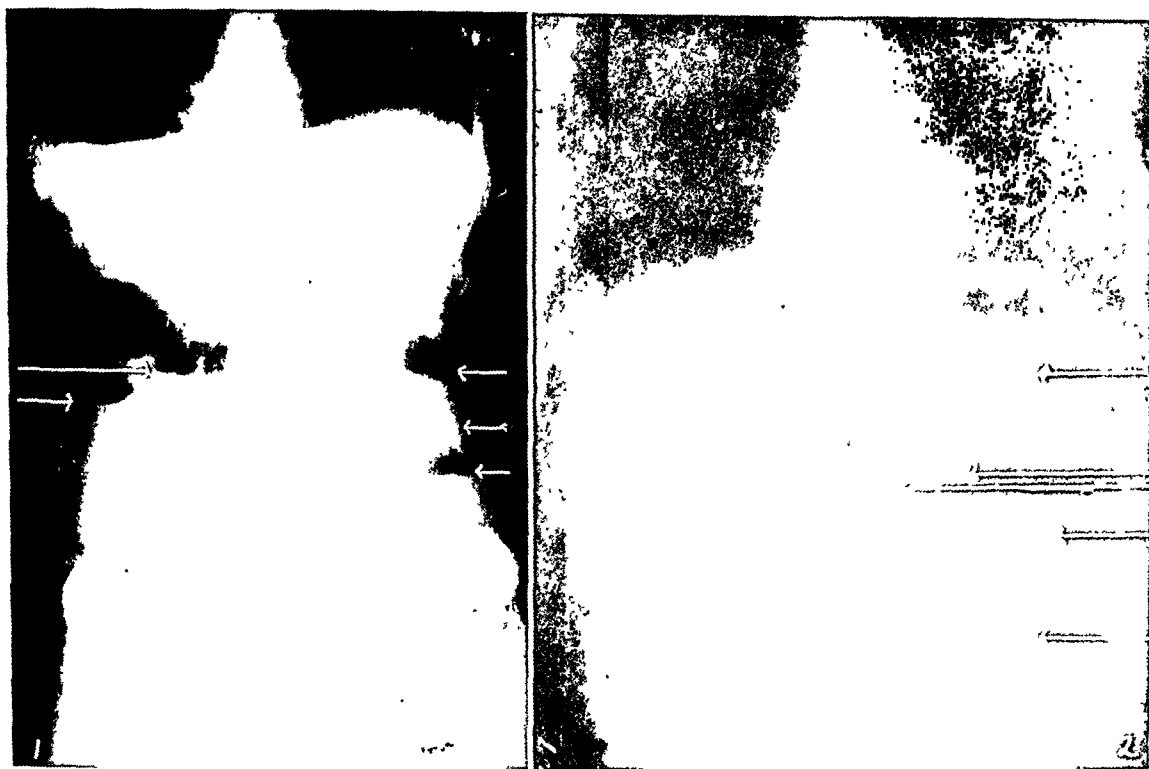
Fig. 1.—M. K., aged forty-three years. Plain röntgenogram of the abdomen of a patient who seventeen days previously had been operated upon, at which time a hysterectomy was performed. Three days before X-ray patient began to have abdominal pains, colicky in nature. Röntgenogram shows dilatation of the intestine with multiple fluid levels, located principally in the upper portion of the abdomen. From patient's history and the characteristic X-ray findings a diagnosis of intestinal obstruction was made. An obstruction was found at the time of operation in the ileum, producing marked dilatation of the gut proximal to it.

Fig. 2.—T. F., aged nine years. Röntgenogram of abdomen of patient who two days previously began having cramp-like pains in the abdomen associated with vomiting and obstipation. X-ray examination—anterior-posterior röntgenogram of the abdomen with the patient in the upright position shows the presence of multiple fluid levels in the upper left portion of the abdomen. A diagnosis of intestinal obstruction high in the intestine was made. At operation a mechanical obstruction produced by fecalith of the ileum was found.

recognition and early relief of ileus is demonstrated by a series of cases recently reported by Miller.[1] Of 343 cases, those which were operated upon within twelve hours showed a mortality of 29.4 per cent; those operated upon with in twenty-four hours, a mortality of 52.9 per cent.; within thirty-six hours, 50 per cent.; within forty-eight hours, 59.6 per cent.: within seventy-two hours, 63.4 per cent.; within ninety-six hours, 72.8 per cent.;

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and over ninety-six hours, 84 per cent.   In a similar series of cases studied by Brill,[2] seventeen cases coming to operation within 12 hours of the onset of symptoms presented no mortality.   In sixteen cases coming to operation between twelve and twenty-four hours after the onset of symptoms, there was a mortality of 12.5 per cent.   In eighteen cases coming to operation within from twenty-four to forty-eight hours, there was a mortality of 61.1 per cent.   It is generally accepted by surgeons today that early operation with relief of obstruction is the only practical treatment of mechanical ileus. In order that an operative procedure may be performed at the proper time it is essential that the diagnosis be made early.

Of greatest importance as concerns the diagnosis in ileus is the history,
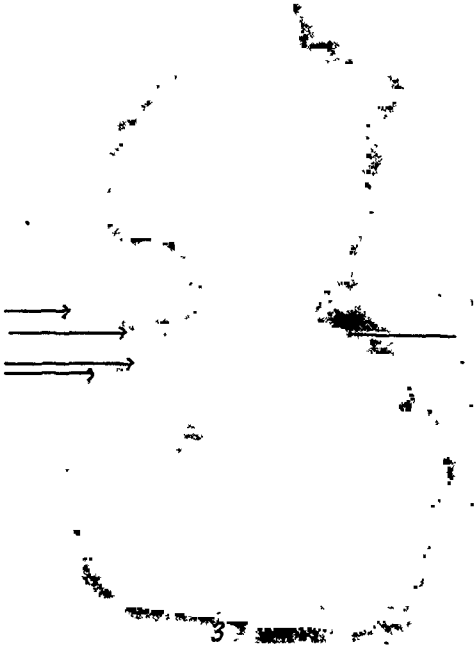
Fig. 3.—Plain rontgenogram of F. S., aged seventy years.   For twenty years patient has had a hernia.   Thirty hours previous to admission to hospital was taken suddenly with severe pain in the abdomen associated with vomiting. Pains cramp-like in character.   Röntgenogram shows the presence of fluid levels in both sides of the abdomen most marked in the upper and outer portions of the right side.   There is some increase in the gas content in the small gut. At operation an obstruction in the region of the sigmoid flexure of the colon was found.

Fig. 4.—Plain rontgenogram of the abdomen of H. C., aged six years, who two days prior to admission to the hospital was awakened suddenly with pain in the abdomen near the umbilicus. Patient vomited and has been obstipated since. Abdomen distended.   Rontgenograms taken with the patient in the upright position shows marked dilatation of the loops of the intestine with parallel transversely coursing loops of bowel in the upper left portion of the abdomen.   Two of these loops show typical serrated outlines.   There are numerous fluid levels present in various portions of the abdomen.   At autopsy and enterolith at about the junction of the jejunum with the ileum was found producing complete obstruction.

which is usually quite typical and characteristic.   The history of pain, which is intermittent and colicky in type, associated with varying degrees of abdominal distention and obstipation, is very suggestive of a mechanical obstruction.   Much more difficult, however, is the diagnosis of ileus developing post-operatively, which may be either of the mechanical or adynamic variety. Here, because of the operative trauma, it is difficult to evaluate the symptoms and signs presented by the patient.   Any additional diagnostic pro-

cedure in this or other types of cases in which the diagnosis may be obscure is of distinct value.

It is generally appreciated at the present time by both surgeons and röntgenologists that the ingestion of opaque substances by patients in whom a suspected obstruction is present is unwise and a dangerous procedure. It has been the experience of most röntgenologists and surgeons that occasionally an incomplete obstruction may be transformed into a complete obstruction by the administration of contrast substances by mouth. The injection of an opaque medium into the rectum as an enema is a justifiable procedure and should be employed in those cases in which an obstruction of the large bowel is suspected. This procedure is, however, of value only in those cases in which the obstruction is located distal to the ileocecal valve.
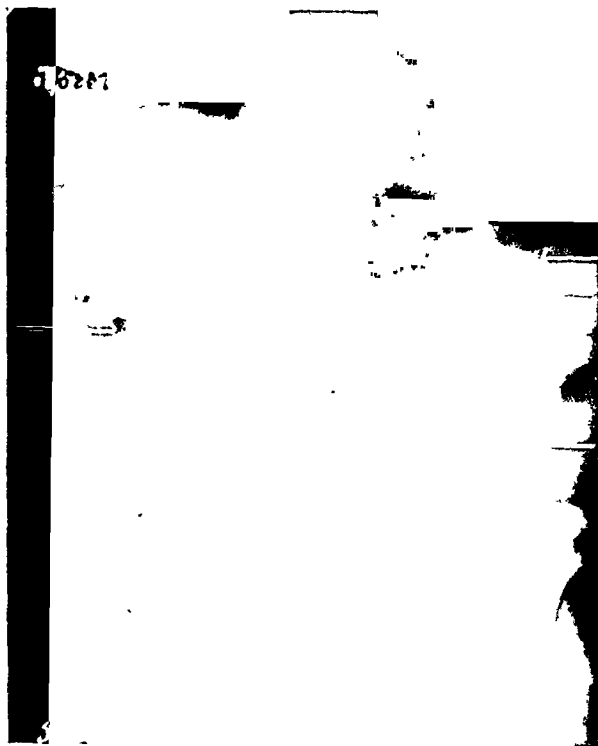
Fig. 5.—J. C., aged thirty-nine years. Plain röntgenogram of a patient who began having colicky pains in the abdomen. X-ray shows marked distention of the colon with several fluid levels, located in the periphery of the abdomen. Operation revealed a volvulus of the sigmoid colon.
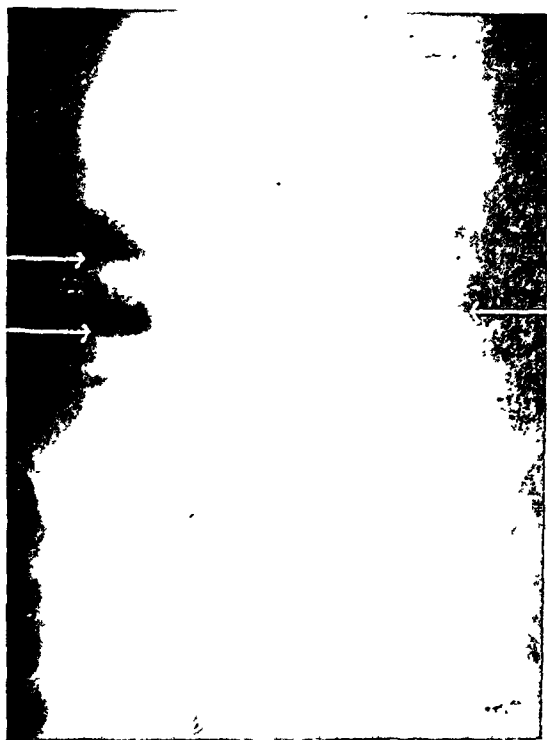
Fig. 6.—Abdominal röntgenogram of F. M., aged twenty-seven years, who for twenty-four hours had had severe abdominal pain, not colicky in nature. Röntgenogram shows numerous fluid levels within abdomen. Operation revealed a diffuse peritonitis due to a perforated gastric ulcer. This is an example of a paralytic ileus.

In 1911, Schwarz[3] advocated the administration of small amounts of barium to patients with suspected obstruction, following which a röntgenogram of the abdomen was taken with the patient in the upright position. In this way numerous fluid levels produced by opaque substance below and capped above by gas were visualized in the abdominal röntgenogram. Even though barium was administered in each of the cases examined by Schwarz,[3] he was able, in several cases, to make a diagnosis of intestinal obstruction even before the barium was given, because of the multiple fluid levels. Two years later, Assmann[4] reported five cases of obstruction of the small intestine, proved to be so by autopsy or operation, in which röntgenograms made of the abdomen without the administration of contrast media showed long and frequently parallel loops of gut which were markedly distended, coursing either obliquely or transversely across the abdomen. Assman[4] made no mention of the position which the patient assumed when the

röntgenograms were made, but in all the röntgenograms which were reproduced multiple fluid levels were present.. In the same year, Hoesslin[5] stated that plain röntgenograms of the abdomen were valuable in diagnosing acute intestinal obstruction and stressed the presence of multiple fluid levels in the abdominal röntgenogram. In 1915, Case[6] emphasized the possibility of making a correct diagnosis of intestinal obstruction röntgenologically by the gaseous distention of the intestine. Case[6] was the first American to call attention to this valuable procedure and merits credit for the pioneer work which he has done in this particular field. He emphasized especially the increase in diameter of the loops of small bowel and the parallel course of the coils of intestine in obstruction of the small intestine. As a characteristic finding he described the serrated contour of the bowel. In his original publication, Case[6] made no mention of the value of the presence of fluid levels in making a diagnosis of intestinal obstruction. The importance of the presence of multiple fluid levels in röntgenograms of the abdomen was, however, stressed by Weil,[7] who believed that this procedure was especially valuable in those cases in which the obstruction was within the small bowel, because normally no air is contained within the jejunum or ileum. Bensaude and Guénaux[8] emphasized the value of this procedure in the diagnosis of stenoses of the large intestine. They found that in obstruction within the large intestine typical collections of fluid capped above by gas could be found. Their best röntgenograms were obtained when the fluid and gas were in the ascending colon from stenosis of the descending colon or sigmoid. Kloiber[9] believes that the presence of multiple fluid levels in the abdomen is pathognomonic of intestinal obstruction. He advocates the taking of the röntgenogram with the patient lying on the side in those cases in which the patient is too ill to sit up. He believes that a positive finding can be obtained within five and a half hours after the beginning of the obstruction. Similar cases have been reported by Milhaud.[10] Within the past three years there have appeared in the American literature, observations by Kalbfleisch,[11] Meyer and Brams,[12] Davis,[13] and Rabwin[14] concerning the use of X-ray examination in the diagnosis of acute ileus. With the exception of Kalbfleisch,[11] these authors have stressed only the presence of gas in the intestines in

FIG. 7.—Röntgenogram of abdomen of M. K., aged forty-three years, who seventeen days previously had had a hysterectomy performed. For two days colicky pains in abdomen. Röntgenogram shows multiple fluid levels in the upper part of abdomen. At operation an obstruction of the ileum caused by adhesions was found.

abnormal amounts and in unusual areas. Kalbfleisch,[11] however, emphasizes the importance of the presence of multiple fluid levels as diagnostic in intestinal obstruction. Case,[15] in 1927, again emphasized the presence of abnormal amounts of gas in abnormal positions. In this publication the possibility of visualizing collections of fluid capped above by gas was mentioned but not especially emphasized. Recently Martens[16] and Hintze[17] have advocated this procedure and have stressed the presence of fluid levels as being especially diagnostic.

Pathologic physiology.—In acute ileus, whether it be of the mechanical or the adynamic variety, there occurs in the intestine a marked dilatation of the gut with an accumulation of an abnormal amount of gas and fluid. This is due in part to obstruction and stagnation of the normal intestinal contents and in part to the lack of absorption of the intestinal contents and to an increase in secretion. Zuntz and Tacke[18] have

shown that normally the gases contained within the intestine are absorbed into the blood-stream and eliminated by way of the lungs. Only a small proportion, about one-tenth of the total gas, escapes through the anus. Any interference with the blood supply of the gut diminishes absorption of the gas, thereby producing overdistention of the intestine. In all cases of ileus, irrespective of the variety, there is some interference with the blood supply of the gut, even though such interference may be entirely intramural. McIver and his associates[19] have shown that if a loop of intestine is distended with air, carbon dioxide is diffused from the blood into the intestinal lumen. Müller[20] has demonstrated that in paralytic ileus, at least, there is a marked increase in the secretions from the gastro-intestinal tract and its appendages. On the other hand, Enderlen and Hotz,[21] Braun and Boruttau,[22] and Esau[23] have found that in intestinal obstruction, absorption from the gut is diminished. From these findings it is evident that very early in the course of ileus, irrespective of the variety, there is an increased accumulation of both gas and fluid within the lumen of the gut. Kloiber[9] believes that such an accumulation is sufficient within five and a half hours so that it can be demonstrated röntgenologically. Case[15] states that enough fluid and gas are present within
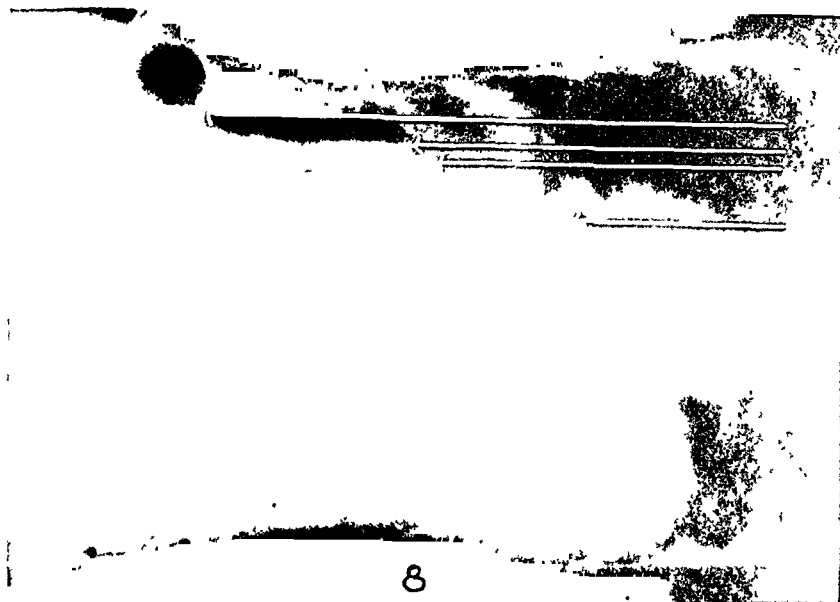
Fig. 8.—Anterior posterior röntgenogram of L. O. taken with patient lying on the right side. For two days patient had had cramp-like pains in the abdomen associated with vomiting. Only slight distention of the abdomen. Röntgenogram shows accumulation of fluid and gas with the production of multiple fluid levels. Operation revealed an obstruction in the lower ileum due to adhesions.

six to eight hours after the establishment of obstruction to be visualized by means of the Röntgen-ray. Wangenstein and Lynch[24] found that within four to five hours after complete occlusion of intestines in animals, there was röntgenological evidence of gaseous distention of the intestines proximal to the obstruction. Whereas they found also an accumulation of fluid proximal to the obstruction, this was less marked than is seen in the human unless saline was administered subcutaneously. In humans, however, the accumulation of fluid as well as gas is a prominent feature in obstruction. In two animals in which a strangulation was associated with the obstruction there was distention of the intestinal loops proximal to the obstruction, but none of the strangulated loops.

Technic.—Schwarz[3] originally advocated the taking of röntgenograms with the patient in the upright position in order that a contrast might be obtained between the fluid below and the gas above. Assmann,[4] Case,[6, 25, 26] Weil,[7] Davis[13] Meyer and Brams,[12] and Rabwin[14] advocated that a röntgenogram be taken with the patient in the supine position. Even though abnormal collections of gas as regards amount and position can be ascertained in most cases of obstruction with the röntgenogram taken with the

patient in the supine position, it seems desirable to the authors to make use of the contrast which may be obtained at the junction of fluid and gas when a patient is placed in such a position and the röntgenogram taken in such a manner as to visualize the surface of the fluid. This may be accomplished by obtaining an anterior-posterior view of the abdomen with the patient in the upright position advocated by Schwarz,[3] Hoesslin,[5] Weil,[7] Bensaude and Guénaux,[8] Kloiber,[9] Milhaud,[10] Wynen,[27] Kalbfleisch,[11] and Ochsner.[28] In those cases in which the patient is too ill to assume the upright position, as is frequently the case in intestinal obstruction, the following procedure may be employed. With the patient in a supine position a lateral röntgenogram of the abdomen is made, or with the patient lying on either side an anterior-posterior röntgenogram is made (Figs. 8 and 9). This has been advocated by Kloiber,[9] Wynen,[27] recently by Case,[15] and Martens.[16] Röntgenograms obtained in this manner produce a picture which is so characteristic of intestinal obstruction, either the mechanical or the adynamic variety, that a diagnosis can be readily made. The presence of numerous fluid levels in various parts of the abdomen is pathognomonic of ileus. If these fluid levels are located principally in the central portion of the abdomen, the obstruction may be con-
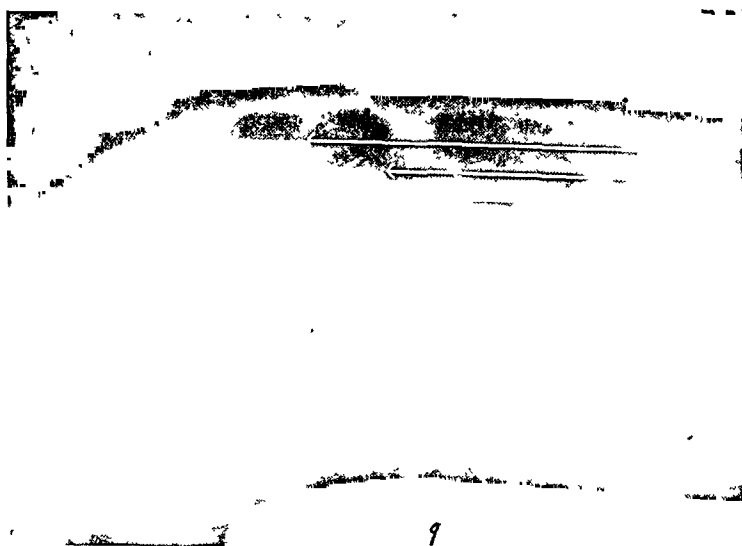
Fig 9.—Lateral röntgenogram of L. O. (Fig. 8) taken with patient lying in supine position. Multiple fluid levels are evident.

sidered to be in the small bowel; if the fluid levels are located around the periphery of the abdomen, the obstruction is probably relatively low in the large bowel. The finding of multiple fluid levels in the abdomen is much more striking than the increase in the amount of gas which is seen in those cases in which the röntgenograms are taken with the patient in the supine position. Characteristic of these plates is dilatation of the loops of gut to two to three times the normal size, which course either transversely or obliquely across the abdomen and a serration of the gut outline when the obstruction is in the small intestine. These findings have been emphasized by Assmann,[4] Case,[6] Meyer and Brams,[12] Davis,[13] and Rabwin.[14]

Within the past two and a half years, plain röntgenograms of the abdomen in cases of probable intestinal obstructions have been made in thirty-two cases admitted to the Charity Hospital, New Orleans. The results obtained by the use of this procedure have been very gratifying. In twenty of the cases, the clinical picture was definite enough that a pre-operative diagnosis of ileus could be made with reasonable safety. The

röntgenogram was obtained as confirmatory evidence. In twelve cases, the röntgenogram was of distinct value as a diagnostic procedure, permitting a correct diagnosis even though the clinical symptoms and signs were not diagnostic.

In all but four cases it was possible for the patient to assume the upright position, *i.e.*, sitting with the radiographic plate against the abdomen during the exposure of the film. In each instance the exposure was made at seven feet.

SUMMARY

1. In acute ileus the administration of opaque media by mouth is dangerous.

2. Plain röntgenograms of the abdomen without the administration of contrast media are valuable in diagnosis of acute ileus.

3. Within a few hours after an inception of an intestinal obstruction there is an abnormal accumulation of gas and fluid proximal to the obstruction.

4. Even though gaseous distention of the intestines as revealed röntgenologically is indicative of intestinal obstruction, the finding of multiple fluids due to the presence of fluid capped above by gas is much more striking and therefore more diagnostic. In order to demonstrate this, röntgenograms should be taken in such a manner that junction of the fluid with the gas may be visualized, *i.e.*, an anterior-posterior view with the patient in the upright position or lying on either side, or a lateral view with the patient lying in a supine position.

5. Results obtained in thirty-two cases of ileus in which this diagnostic procedure was used are reported.

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FIBRO-SARCOMA OF THE MEDIASTINUM

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GREAT progress in chest surgery cannot be obtained until thoracotomy has become a safe procedure and until diagnostic thoracotomy has left us in no doubt. As no general surgeon has done a sufficient number of thoracotomies to form an opinion entirely acceptable to others, it will not be amiss, nay, it becomes the duty of every one who has had experience with thoracotomies to report his experience. It is with this in view that I here report the following case.

A man, H. C. K., fifty years of age, married and father of eight children, was operated upon for gall-stones in 1916. Gall-stones were removed and the appendix vermiformis also. The gall-bladder was not removed. Good recovery. No recurrence. September 17, 1927, he consulted Dr. W. D. Sexton, complaining of general weakness, general malaise, slight cough, and shortness of breath, and at times pain in his left chest below the heart. No bloody expectoration, no night sweats. His face was slightly flushed. There was limited respiratory movement over the entire left chest, also flatness on percussion, except over the upper and anterior part where there was resonance. Vocal fremitus absent. Breath sounds very distant, hardly audible. No râles. Percussion of right chest is hyper-resonant. Here breath sounds are slightly exaggerated, no râles. Heart inside of left nipple line. Temperature normal. Fluoroscopic examination gave darkness over entire left side of chest (Fig. 1).

He was subjected to aspiration September 19, 1927. Physical findings as before. A needle inserted in the mid-axillary line between the seventh and eighth ribs was without results, as also was the insertion in the fourth intercostal space, slightly more posterior. A third puncture made posteriorly about four inches from the spine was positive and about 1000 cubic centimetres of a bloody fluid was withdrawn. The patient felt easier after this. Five days later additional fluid to the extent of 700 cubic centimetres was aspirated.

An X-ray examination on September 20 and October 1 showed almost the same picture as was obtained before punctures were made, except that now it was apparent that the heart and mediastinal contents were displaced more decidedly to the right than was noticeable before the aspirations.

October 3, feeling much improved, he returned to his home. On October 21, while at his office, he became quite excited regarding a business transaction. He talked incessantly and irrationally. The next day he was decidedly better and was feeling well. The pulse and temperature were normal. On the morning of October 24, he became very irrational. He was taken to the hospital and his nervousness controlled by morphine and scopolamine. Glucose was given per rectum, and the patient returned to a normal condition in about two days. From then on he relapsed at intervals into a state of irrationality, which at one time at least increased to maniacal proportions.

Examinations of his urine were made frequently. It occasionally showed a light trace of acetone. He had a trace of albumen but at no time showed evidence of uræmia. On two or three occasions his pulse would suddenly become very weak and thready, but under the influence of morphine would improve and become normal again. Two aspirations resulted in the removal of but small amounts of fluid. The doctor had the sensation that the needle entered a solid mass or tumor, and the patient was advised to

consent to an exploratory thoracotomy in the hope that this tumor might be removed. The case was then referred to Dr. K. W. Doege for exploratory thoracotomy.

November 7, 1927, under local para-vertebral anæsthesia, the patient being in a semi-sitting, semi-reclining position and on his right side, an incision about ten inches in length was made, beginning posteriorly at the level of the fourth rib and sloping downward and forward ending at the tenth rib in the anterior axillary line. The skin and muscles were reflected to both sides and the sixth, seventh, eighth and ninth ribs exposed and laid bare. These ribs were resected sub-periosteally to the extent of about four to six inches. After all hæmorrhage had been stopped the chest cavity was opened by forming a horseshoe flap of the intercostal muscles and beds of the ribs, the base being at the lower border of the fourth rib. A turbid, milky fluid escaped and a solid pale-

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H C.K.

FIG. I —Chest before operation.

looking tumor, apparently filling the entire left thoracic cavity, became visible. It extended from the apex of the chest to the upper surface of the left diaphragm, pushing the latter downward and forward and forming a concavity instead of a convexity in the diaphragm.

The tumor was hard, not nodular, and adhered in many places to the parietal pleura. These adhesions were not firm and gave the impression that they were the result of repeated former punctures. The lung and heart could not be seen through the thoracic opening as the entire mediastinum and its contents were pushed over into the right pleural cavity. The adhesions were easily separated and the tumor became quite movable especially at its lower end. The upper end could not be reached through the opening. The movability of the mass made it appear probable that it could be removed. By this time the patient showed signs of weakness and having lost considerable blood it was thought best to interrupt the operation, especially as we had no knowledge of the extent to which the tumor might be attached medially; i.e., to the lung, heart, vessels and mediastinum, and, therefore, could not judge of the difficulties we might

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encounter. The horseshoe flap was placed loosely over the tumor and the skin incision closed by interrupted sutures. At the close of the operation the patient's pulse was 120 and of good quality. The only time he had a weak and irregular pulse was when we explored toward the lung and mediastinum. The patient was not any the worse for the operation except that his hæmoglobin, which had been 80 per cent before, had dropped to 55 per cent.

November 11, four days after the operation, we transfused 350 cubic centimetres of blood and on the next day, November 12, followed it up with the final operation. The size of the tumor made it necessary to enlarge the incision and to remove more ribs in
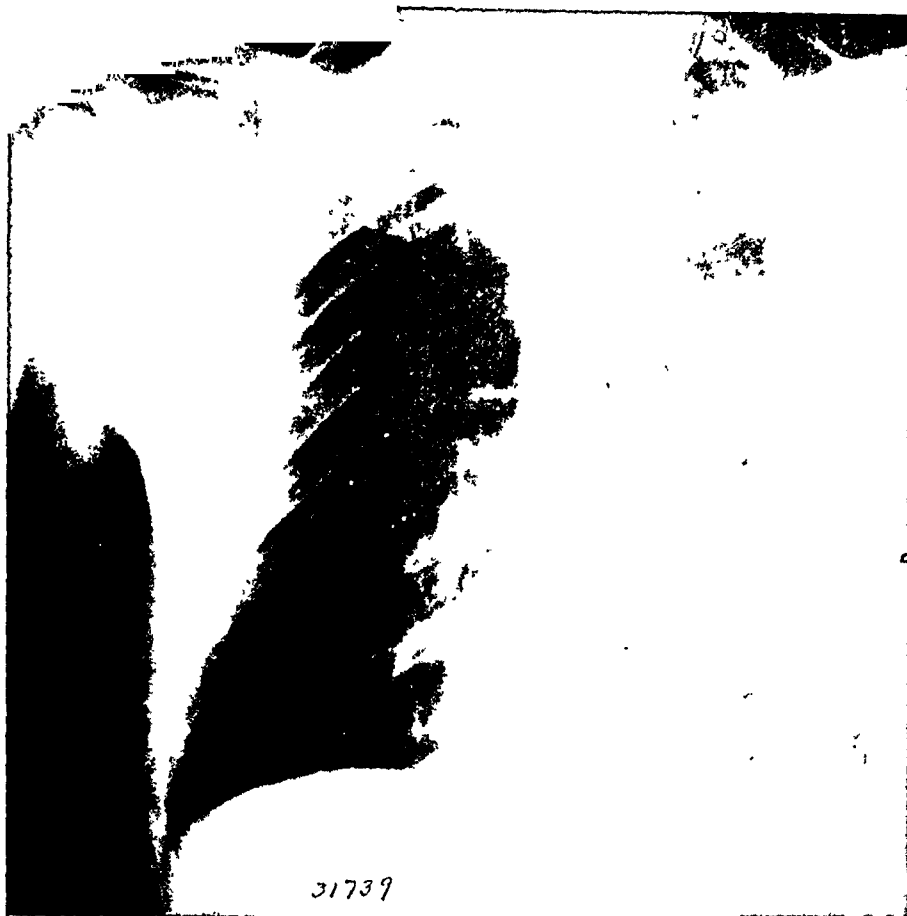
Fig. 2.—Chest about three weeks after operation.

order to get it out of the thoracic cavity. Under para-vertebral anæsthesia the incision was extended upward to the top of the shoulder and three inches of the fifth, fourth and third ribs were removed and the remaining costal wall incised upward. Now almost the entire length of the tumor could be seen except the apex which, however, could be surrounded by the palpating fingers. Palpating the tumor it became evident that it could be lifted from the thoracic cavity. The lungs and heart were still not visible. Remembering our experience at the first operation when palpation in the region of the mediastinum had resulted in a small, irregular pulse and signs of collapse, I decided at this stage to give the patient gas anæsthesia to diminish and possibly avoid nerve reflexes and shock from handling the lungs and the heart.

Under gas anæsthesia, the tumor was gradually lifted from its bed and pulled outward. Now the pericardium with the slowly pulsating heart could be seen, the lung began to inflate slowly and move from the right pleural cavity across the spine to the left side. The middle lobe of the lung was densely adhering to the tumor to the extent of a fifty-cent piece. The rest of the lung was free. The arch of the aorta could easily be made out and a pedicle led from the upper and inner aspect of the tumor toward the mediastinum, but no attachment to any special organ could be made out. This

pedicle was surrounded by a ligature and then tied off. By this time and while attempting to separate the adhesions to the lower portion of the upper lobe of the lung respiration of the left lung became active and violent and the adhesion tore away, releasing the tumor and lung.

The tumor being out, the left lung now expanded with each inspiration and collapsed suddenly with the expiration, causing a violent flapping of the lung and mediastinum, and serious heart irregularity resulted. Separation of the pulmonary adhesion had resulted in a tear in the lung and a bloody foam exuded from it. I made an attempt to grasp this place with forceps and to sew the tear, but the breathing became so violent that further tears resulted in the attempt. It became evident that the patient's condition was critical and that the violent motion and flapping of the mediastinum must be stopped to avoid serious heart reflexes. Several large pieces of salt gauze packing were pushed against the lung and mediastinum and held there, steadying its action. The patient's condition now began to improve.

Fearing renewed cardiac disturbances the attempt to suture the lung was abandoned and the operation ended. The packing was left in place and the chest cavity closed,

FIG. 3.—Gross appearance of tumor. Long diameter—10¼ inches. Transverse diameter—6¼ inches. Largest circumference—25 inches. Short circumference—17 inches. Weight—4½ pounds.

permitting the ends of the gauze to protrude from the lower extremity of the incision. The pleura and intercostal muscles were reunited as far as possible and the skin closed by interrupted silkworm-gut sutures as far as the protruding drains. The entire length of the incision was eighteen inches.

Post-operative progress: There is not much to be said regarding the post-operative history. At no time did the patient seem to be in real danger. There was a moderate febrile reaction during the first week. December 1, i.e., nine days after the operation, it was deemed best to give the patient another blood transfusion from which he derived marked benefit. The gauze packs were gradually removed so that after two weeks a rubber drain could replace the gauze. Subsequent X-ray examination disclosed the fact that, while a pneumothorax was still present, the left lung was expanding gradually and the heart was approaching its normal position. The space in the right thorax was not encroached upon any longer and the lung was expanding normally. The mediastinum with the trachea had moved back to its position behind the sternum and the wound was heading satisfactorily. The patient gained in strength, had no dyspnœa, was rational and sat up in bed after eighteen days and left the hospital six weeks after the operation. The sinus in the left chest continued to discharge for several months. The

fistulous tract ultimately closed spontaneously. To all appearances the patient now is a well man, his strength has returned and he is back at his business.

Specimen (Fig. 3): An oval, solid tumor, having the shape and size of a football, pale in color, long diameter 10¼ inches, transverse diameter 6¼ inches, largest circumference 25 inches, short circumference 17 inches. Weight 4½ pounds.

Microscopic examination (Figs. 4 and 5): Slides show a highly cellular structure composed of atypical cells of the fibro-blastic series. The tumor cells are well differ-
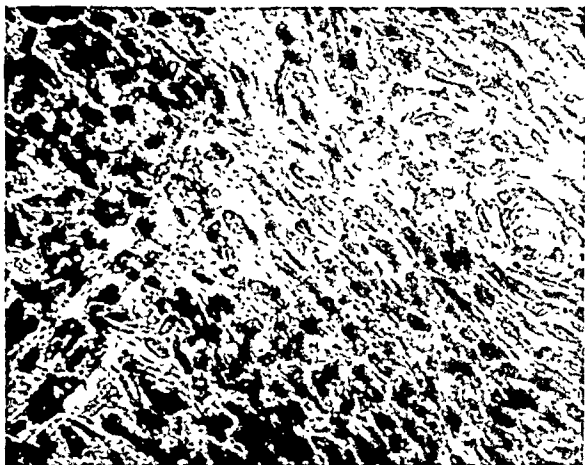
FIG. 4.—Slide—fibro-sarcoma—high power field.　　FIG. 5.—Slide—fibro-sarcoma—low power field.
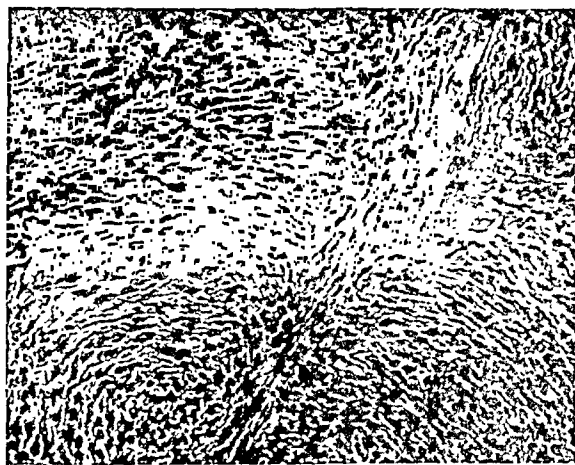
entiated and mitotic figures are occasionally seen. Diagnosis: Fibro-sarcoma, low-grade malignancy.

Epicrisis: From the nature of the growth it is safe to assume that the tumor was of fairly slow development even though the subjective complaints were of but short duration. The rather acute development of symptoms can readily be explained on the assumption that it was the rapidly forming pleural exudate that finally brought on the severe cough and dyspnœa. But how explain the maniacal seizures during the last two weeks? In the absence of kidney complications, a toxæmia from that source can be excluded. It is more than likely that the extreme displacement of the heart with the resulting torsion and displacement of the large arteries and veins resulted in serious interference with the cerebral circulation. The veins being much more easily compressed through torsion and displacement of the heart than the arteries would cause venous cerebral congestion, insufficient oxygenation of the brain cells and consequent mental unbalance. Lack of nourishment to the brain and accumulation of toxæmia in the brain could induce mental disturbances in the case under consideration just as readily as these disturbances are frequently noticed in cases of prolonged cardiac failure. In the absence of fainting spells and facial pallor or signs of anæmia of the brain it could not have been the arterial blood supply that failed and it is most likely that the venous return was responsible for the occasional cerebral disorders, as the patient's face appeared rather flushed.

Inefficient respiratory exchange could, of course, also have resulted in toxicity of the blood and mental incoherence. However, such toxicity would most likely have led to coma rather than to violent maniacal seizures.

To perform the operation in two stages was probably a wise thing to do under the circumstances as the loss of blood during the one stage had increased the anæmia decidedly. It appears to me now that with a little more forethought and better preparedness immediate suture of the lung might have been accomplished. A dull forceps, say a ring forceps, might have grabbed the lung with less danger of tearing. The lung could have been pulled away from the mediastinum and, by thus steadying it, we would have prevented the violent flapping of the mediastinum and avoided the serious pleural and mediastinal reflexes. Then suture of the torn lung tissue could have been done at leisure and more accurately. It also would have been possible to inflate the lung and to close the pleural cavity instead of draining it. More rapid and more complete expansion of the lung from the first would have been possible. As in the peritoneal cavity, closure of the pleura without drainage should be the aim. Even if a certain amount of infection of the pleural cavity can be anticipated and even if a serous or bloody exudate can be expected, I would still think it best to close the pleura without drainage. For if a pleural exudate should form and were large enough to need attention, aspiration can be done easily and repeatedly.

Finally, theoretically it must be considered an error not to have radiated the chest to prevent recurrence of the growth, but the patient refused. It is now three years since the operation and there is no evidence of recurrence.

CORRIGENDUM

On page 529, October ANNALS, 7th line from the top, instead of 1810 read 1910.

TUMORS OF PERIPHERAL NERVES*

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THE term neuroma was introduced into medical literature by Odier of Geneva in 1803. The term was applied by him to tumors formed by the diseased enlargements of nerves. William Wood published in the *Transactions* of the Medico-Chirurgical Society of Edinburgh, appearing in 1829, records of some twenty-four cases of neuroma which he had collected from various sources. A clear description of the anatomical and clinical features of these enlargements was given. In this paper Wood cited eight cases in which the tumor had been successfully removed. Some of these are of considerable interest. One appeared in Cheselden's "Anatomy of the Human Body," published in 1773; another in the "Encyclopédie Méthodique de Chirurgie," Paris, 1792, and in this instance an amputation was performed for what was undoubtedly a plexiform neurofibroma of the median nerve in the forearm. Another case was reported in a paper by Sir Everard Home. He describes a case in which he was assisted by John Hunter in the removal of a tumor from the musculocutaneous nerve in the arm. Another case is recorded by Sir Charles Bell, in which he removed a tumor from the internal popliteal nerve. Wood believed that these growths developed from the connective tissue of the nerves and not from nerve substance proper.

A number of articles dealing with neuromas were published during the succeeding years. Smith, of Dublin, in 1849, recognized that neuromas might be of spontaneous origin, or that they might follow division or injury of a peripheral nerve. He gave an exhaustive account of "multiple neuromata," based upon autopsy findings in two remarkable cases. He did not believe, however, that the tumors were composed of nerve tissue. He thought that they developed from the connective tissue. Sarcomas of nerves were not mentioned in these early publications.

With the introduction of new histological methods and improvements in histological technic, a new classification of neuromas appeared. Heretofore, the term neuroma had been applied rather indiscriminately to tumors of different kinds and to a number of lesions affecting nerves which were probably not tumors. The histology of nerve.fibres had advanced considerably

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* Read before the American Surgical Association, May 16, 1930.

when Virchow, in 1863, gave a classification of these tumors based upon a structural instead of a clinical basis. He divided these tumors first into the true and false. The true neuroma was defined as a tumor which was composed for the most part of newly formed nerve tissue. The false neuroma was thought to be composed of connective tissue derived from the sheaths of the nerve. He divided true neuromas into three groups—the neuroma gangliocellulare, composed of newly formed nerve cells; the neuroma fibrillare amyelinicum, composed mostly of non-medullated nerve fibres; and the neuroma fibrillare myelinicum, composed chiefly of medullated nerve fibres. Virchow thought that many of the cases of neurofibromas were in reality true neuromas, composed of non-medullated nerve fibres. Nerve fibres might, however, easily be mistaken for connective tissue fibres, if special staining methods were not employed. He also suggested that a true neuroma might be converted into a fibroma, if pressure caused disappearance of the nerve fibres. The histological structure of these tumors revealed by the use of specific stains, indicates that many of Virchow's contentions as to the structure of these tumors can no longer be maintained.

In the Laboratory of Surgical Pathology of the Johns Hopkins Hospital are over 180 tumors which are classified as fibromyxomas or fibromyxosarcomas of peripheral nerves. About forty of these tumors were placed in the sarcoma group. The sections of the tumors were restudied. The typical benign tumors, showing in places the palisade arrangement of the nuclei and in other areas the reticular structure (to be discussed in more detail later), could be easily picked out. The tumors occurring in von Recklinghausen's disease and sarcomas arising from nerves could not be so easily distinguished. All the histories were then reviewed. In some the data were incomplete; in many there was no positive evidence that the tumor was connected with a nerve. It should be noted that the connection of the typical benign tumor with a nerve could be easily demonstrated. All the sarcomata included in this paper had a definite origin from or connection with a nerve.

Thirty-seven cases of proven peripheral nerve tumors were available for study. These are classified as follows:

Neurinomas (with palisade arrangement of the nuclei and reticular structure) 11

Benign tumors (sections lost; diagnosis made from history and original pathological notes) 4

Sarcomas 3

Von Recklinghausen's disease without tumors of deep nerves 5

Von Recklinghausen's disease with deep nerve tumors, malignant 4, benign 7 11

Localized cutaneous neurofibromatosis 1

Tumor in neck, one showing ganglion cells 2

Benign Solitary Tumors, Neurinomas, Perineurial Fibroblastoma (fourteen solid, one cystic).—All of the solid tumors occurred in adults, the ages of the patients ranging from twenty-eight to sixty-five years, the average

being forty-four. They were equally distributed between males and females. The duration of the tumor before removal by operation in the twelve cases in which it was recorded ranged from six months to ten years, with an average duration of three and one-half years.

The distribution according to nerves is as follows:

Median 3
Radial 2
Sciatic 2
Posterior tibial 2
Cutaneous branch of external popliteal 1

Cutaneous branch of posterior tibial 1
Branch of intercostal nerve 2
Lesser internal cutaneous 1
External popliteal 1
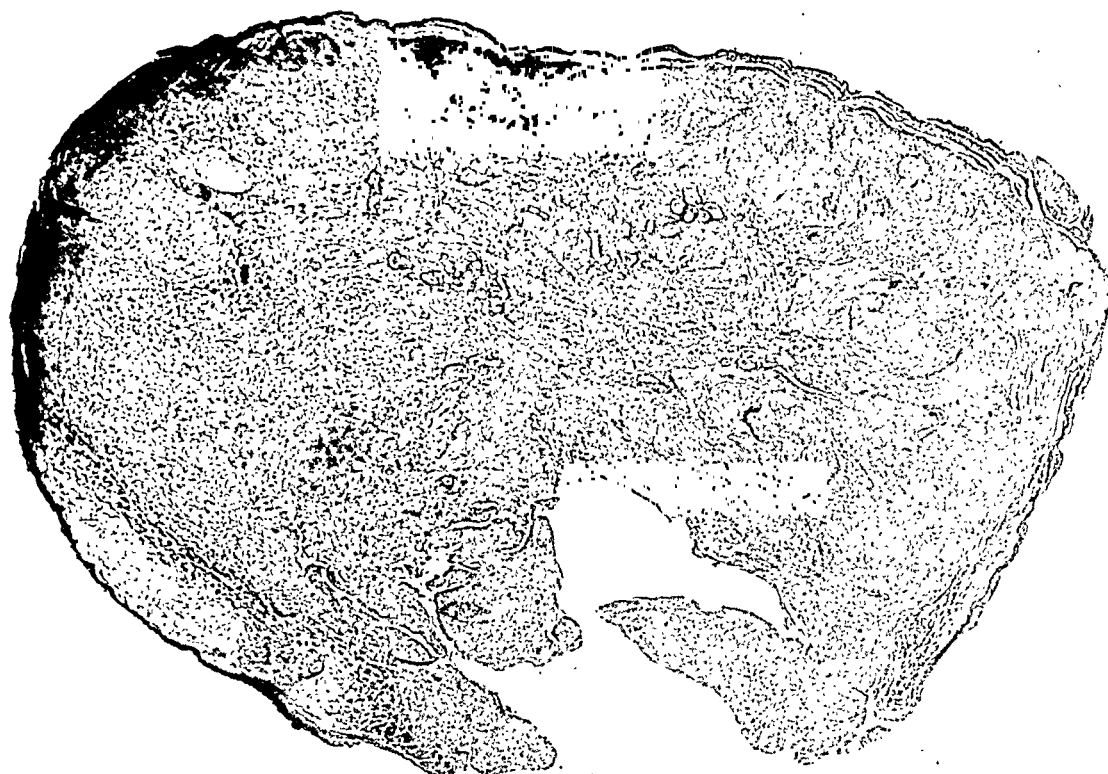
FIG. 1.—Solitary tumor (neurinoma, perineurial fibroblastoma) removed from the left median nerve in the lower part of the axilla. Capsule of tumor is broken at one point. In the middle part of the upper portion are islands of type A tissue. The greater part of the tumor is made up of type B, reticular tissue. Myxomatous changes have occurred in the tumor.

The three following histories will be cited to indicate the clinical characteristics of the benign group of tumors. These three cases are selected as they are typical.

CASE I.—Mrs. S. G., aged fifty-four years, was admitted to the Johns Hopkins Hospital, January 26, 1928. A year before admission she first noticed a shooting pain down the outer surface of the left arm. She did not pay much attention to this at first. It became more severe. Five months before admission a small, tender swelling was noted under the left arm just below the anterior axillary fold. When pressure was made upon this nodule pain radiated into the forearm and hand along the distribution of the

FIG. 2.—High power of a section of preceding tumor showing typical palisade arrangement of the nuclei. This arrangement is characteristic of this type of tumor of nerve trunks. It should be remembered that a similar histological picture may be found in a rapidly growing myoma.

FIG. 3.—High power of a section made from a tumor arising from the dorsal root of a spinal nerve, showing the typical histological picture of type A tissue found in neurinoma (perineurial fibroblastoma).

FIG. 4.—High power of a section through a solitary tumor removed from the left popliteal nerve. This tumor had a myxomatous appearance. Some funiculi were resected in removing this tumor, the major part of which could be enucleated. This tumor was composed almost entirely of type B, the loose reticular tissue, with a tendency to myxomatous changes, described by Verocay.

FIG. 5.—High power of a section of large tumor removed from the sciatic nerve. Resection of the nerve was necessary because several funiculi passed through the tumor. This is the only one of fifteen solitary tumors which required resection. End-to-end suture performed. No recurrence after almost two years. Considerable return of function. Whorls of type A tissue with palisade arrangement of nuclei are interspersed among reticular type B tissue.

median nerve. There has been no numbness, tingling or weakness of the parts to which the pain has radiated.

On January 27, 1928, under local anæsthesia, the trunks of the brachial plexus were exposed and the nerves blocked. A small tumor was found in the median nerve. The sheath of the nerve was split and a tumor as large as a large hazelnut was shelled out. The tumor could be removed without sacrificing any nerve fibres. The sheath of the nerve was then sutured with fine silk.

This patient has fully recovered. For a while she complained of some peculiar sensory disturbances over the course of the median nerve. These have disappeared and there have been no evidences of return of the tumor. The histology of the tumor, which grossly had a myxomatous appearance, will be discussed later.

CASE II.—M. C., colored, female, aged forty-three years, was admitted to the hospital March 29, 1930. She complained of a lump in her left thigh posteriorly about the middle. She also complained of pain which radiated to the knee and into the foot. Her symptoms dated from April, 1922, and began four months after an operation for a "tumor of the stomach" when she accidentally discovered the lump referred to above. The lump has not increased in size since its discovery. Several weeks ago, while in bed, she experienced suddenly sensations of pins and needles in her left foot. This was followed by aching pains in the sole of the foot, big toe and knee. The pains were not increased by standing and walking. They occurred chiefly at night. Some tenderness is noted over the lower pole of the tumor.

On examination a circumscribed, deeply located tumor is found on the posterior side of the left thigh at the junction of the middle and lower thirds. Pressure upon this causes pain to run down the patient's leg over the distribution of the great sciatic nerve. No impairment of the functions of the leg and foot is observed. Sensation is preserved.

April 3, 1928, the tumor was exposed and the sciatic nerve mobilized. An attempt was made to enucleate the tumor, but the fibres of the sciatic nerve were incorporated in it and a

FIG. 6.—The tumor described in FIG 5 may be seen forming a prominence on the posterior surface of the thigh about the middle.

resection of the nerve was necessary. An end-to-end suture was performed. The knee had to be flexed at a right angle in order that the nerve suture could be performed. A plaster-of-Paris case was then applied. The leg was gradually extended to its normal position after eight weeks.

The tumor was about the size of a hen's egg. Grossly it had a myxomatous appearance. The funiculi of the nerve were so closely related to the tumor that enucleation was impossible.

This patient was examined July 10, 1930. There has been a marked improvement in function. Plantar flexion is relatively strong. There is some dorsal flexion. The patient walks without the aid of a cane, and although there is some foot drop the toe of the shoe is no longer scraped.

CASE III.—C. D., white male, aged sixty-three years. The patient first noticed a mass in the back of the left thigh three years ago. Two years ago pain, which ran down the left leg into the foot, particularly to the dorsum of the foot at the base of the great toe, was noted. This pain has become decidedly worse and more persistent. It is now constant, but varies in intensity. There is no difficulty in walking, and walking does not make the pain more intense. The left leg seems to be colder than the right. The patient complains considerably of the cold sensation and wears an extra sock to counteract it.

FIG. 7.—Sarcoma of the sciatic nerve. Exceedingly rapid growth. Metastatic nodules have formed along the course of the nerve and extended toward the pelvis. Thigh amputation after attempt to cure by resecting the sciatic nerve.

FIG 8.—Tumor of the sciatic nerve and its branches. Small nodules may be seen in the branches of the nerve below the site of the original tumor.

A small, ill-defined mass is found in the left buttock near the gluteal crease. This measures about three centimetres in diameter. Another mass is found in the upper part of the popliteal space along the course of the great sciatic nerve. This is not attached to the skin. It is deeply situated, and it is difficult to outline the tumor accurately. Sensation is not interfered with and there is no loss of motor function.

October 10, 1929, the left sciatic nerve was explored under local anæsthesia. The incision was above the site of the tumor, which was not located. A definite localized fatty mass was removed. The symptoms persisted. When the patient was in the right position the mass could be located, and on December 13, 1929, another operation was

performed. This was begun under local anæsthesia, but had to be continued with gas. The tumor was exposed and the internal popliteal nerve mobilized. The tumor was apparently encapsulated. The nerve was split. Most of the tumor could be enucleated. Some funiculi were so closely attached to the capsule that they had to be sacrificed. These funiculi happened to be sensory. The patient has some anæsthesia on the back of the leg.

This tumor resembled the other two in gross appearance. It was myxomatous. Throughout the solid parts of the tumor were small cysts. Scattered throughout the tumor were small yellowish areas.

The three tumors just described are typical of the remaining twelve of the benign group, and the other histories and microscopic findings will not be discussed. They belong to a group of tumors to which Verocay has given the *name of neurinoma. These tumors clinically are benign. Some have undoubt-*edly been classified as sarcomas or fibromyxosarcomas. Because of areas of localized nuclear richness they have been regarded as resembling histologically tumors arising in other tissues which run a malignant course. Verocay first recognized the nature of these tumors and believed that they were composed of tissue which had some relation to the sheath of Schwann. The neurinomatous tissue is of two types. Type A is characterized by a palisade arrangement of the nuclei. The tissue is decidedly polar in arrangement and appears in long bundles or strands. The so-called nuclear rows of Verocay appear only in type A tissue. They are quite characteristic. The nuclear arrangement with polarization reaches its highest expression in neurinomas, and may be considered characteristic of them. This type may be relatively abundant in some tumors; in others there may be but little. In some there may be none of this type. Transitions between types A and B are found, type B having apparently differentiated from type A. There is a tendency for hyaline degeneration to occur in the intercellular substance of the type B tissue. This degeneration occurs in this type only, and sometimes to a high degree. It gives to it the glistening appearance and transparency of connective tissue hyaline. This tissue is, as a rule, softer than that of even a soft fibroma. If smaller or larger masses of the hyaline material fuse and swell, cyst-like structures are formed, which displace neighboring tissue and lead to a thickening of the same, which form a capsule about the tumor. Types A and B occur together in many of these tumors. The transitions between the two may be gradual. In some instances they are sharply demarcated from each other. In other tumors type A tissue occurs in sharply delimited islands scattered throughout the reticular type B tissue. Type B tissue is found in all tumors, while type A is absent relatively often. The whorls and vortices of type A may be preserved in type B, but are made up of a different tissue.

The histological structure of these tumors is well illustrated by the tumors which were removed from the three cases cited.

Fig. 1 is a photograph of a cross-section of the tumor removed from Case I. The capsule of the tumor has been broken at one place. Along the middle of the upper

border of the tumor is an area of solid tissue occurring in islands, some of which are more or less fused. This is type A tissue. The greater part of this tumor is made up of the reticular type B tissue in which changes had occurred, giving rise to the myxomatous appearance of the tumor.

Fig. 2 is a photomicrograph through the tissue at the middle of the upper border of the tumor. The palisade arrangement of the nuclei and the polar arrangement of the fibrils are well shown in this section.

Fig. 3 is a photomicrograph of a section through the tumor of the sciatic nerve described under Case II. Islands of type A tissue with the palisade arrangement of the nuclei may be seen. These are surrounded by type B tissue, in which the changes giving rise to tissue of a myxomatous appearance occur.

Fig. 5 illustrates the vortices and whorls of type A tissue in a tumor removed from the sciatic nerve. The palisade arrangement of the nuclei is well shown in this section. Transformation of this into type B may occur, but when this occurs the whorl and vortices arrangement is preserved.

The same tissue is found in spinal-cord and spinal-nerve tumors. It is also found in dural endotheliomas and acusticus tumors. A palisade arrangement of the nuclei and tissue resembling the type A is found also in some myomas and myosarcomas.

As already stated, Verocay was the first to suggest that these tumors were composed of a tissue which had some relation to the sheath cells, and gave to them the name neurinomas. Penfield has remarked that the term neurinoma—applied to the solitary nerve tumor—has been unfortunately widely accepted. The term conveys a definite meaning and will probably remain in the literature. Although there may continue to be discussion as to the tissue involved, the term conveys a very definite meaning. The presence of this tissue in both solitary tumors and the tumors of von Recklinghausen's disease led Verocay to assume that the tumor develops from the sheath cells. These tumors do not arise from the sheath cell, which is of ectodermal origin, but from connective tissue sheath about the fibrillæ.

Fifteen solitary tumors of peripheral nerves compose this group. Fourteen have been enucleated from the nerve. In one case the sciatic nerve had to be resected. On gross examination they appeared myxomatous. These are benign tumors, as none has recurred. They have a definite histological structure and belong to the neurinoma or perineurial fibroblastoma group. The nearer the periphery the tumor is located, the more the type B tissue predominates over the type A.

Von Recklinghausen's Disease (Neurofibromatosis).—It should be remembered that patients with this disease do not come to the hospital for treatment until the superficial tumors are large enough to cause disability or disfigurement, or until the involvement of deep nerves gives rise to symptoms. A few of the patients under consideration were admitted for other conditions. One patient came to the hospital to have all the skin tumors, numbering 118, removed. The group considered in this paper must be regarded as representing the late rather than the early stages of von Recklinghausen's disease.

There are sixteen cases in this group. The ages range from four to fifty-six years. The small skin tumors and pigmented areas dated from birth

or childhood in the eleven cases in which a note was made as to duration. Frequently the tumors reached a certain size and then ceased to grow. Other tumors continued to appear either as new developments or as the result of growth of minute nodules which had not been discovered previously. The superficial tumors, as a rule, were widely distributed over the trunk, head and extremities. Three of the patients with superficial tumors, without evidence of deep lesions, requested operation because of the size of one or more tumors. One patient entered the hospital for the excision of all the visible nodules. A tumor was removed for histological study from a patient on the
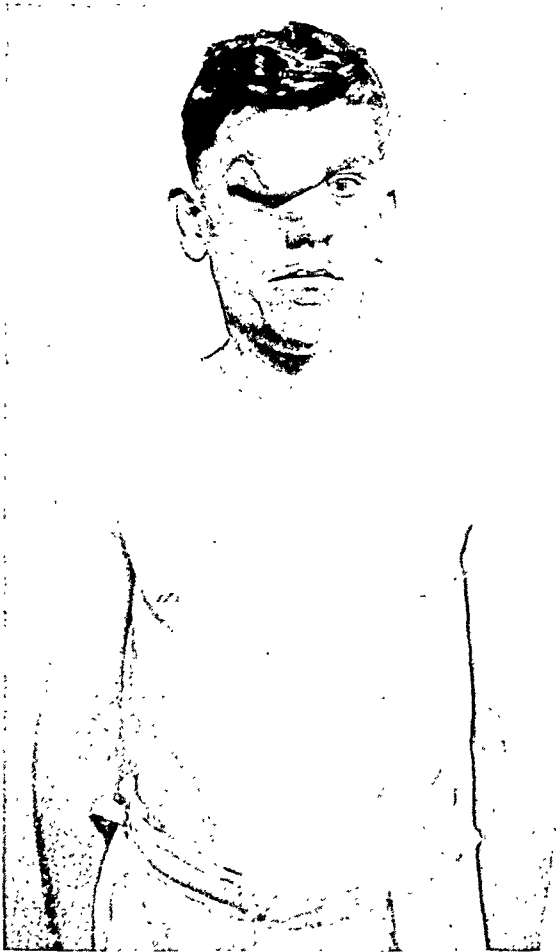
FIG. 9.—Von Recklinghausen's disease with multiple subcutaneous nodules and a lobulated mass over the right eye.
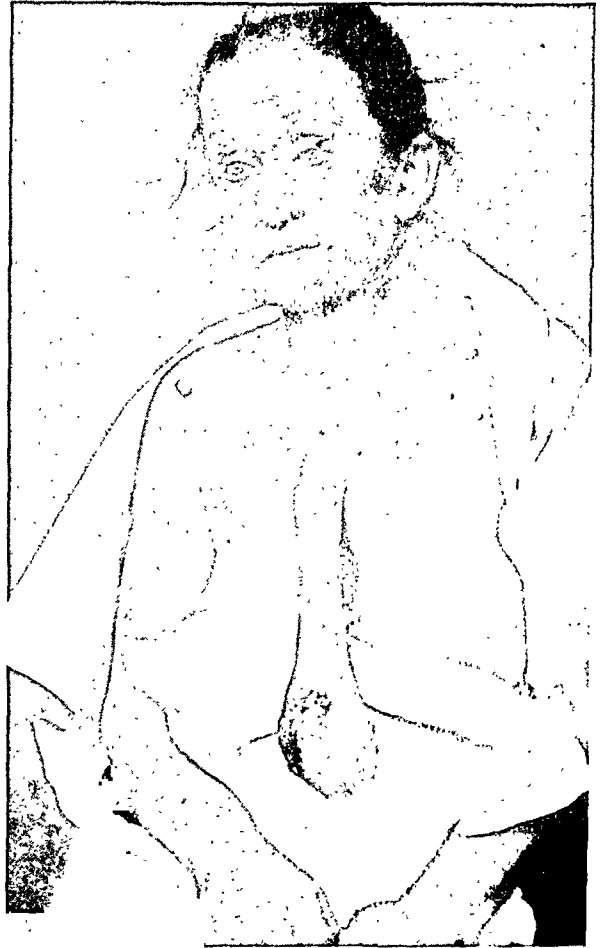
FIG. 10.—Von Recklinghausen's disease. Multiple nodules in the skin with pigmentation of skin and a pendulous tumor of the chest wall.

obstetrical service. In some instances the superficial tumors were scattered indiscriminately over the body. In a number of cases, however, there was a linear arrangement along the superficial nerves, usually a symmetrical distribution. Pigmentation of the skin was mentioned seven times, but it was undoubtedly present in other cases. The areas of pigmentation varied in size from a few to as many as six to eight square millimetres. These areas were scattered irregularly over the body and extremities.

In this group of sixteen cases there were five without and eleven with deep nerve tumors.

The following are examples of neurofibromatosis in which the deeper

nerves are not involved. These cases are not uncommon, and the histories of but three cases will be given.

E. S., colored female, aged twenty-six years, states that she had tumors of the skin as long as she can remember. She has had paræsthesia of the extremities and has been unable to walk since having a hernia repaired several weeks ago under spinal anæsthesia. Pigmentation of the skin is marked. She thinks that more nodules have appeared in the skin over the chest during the past week.

On examination numerous subcutaneous and deeper nodules of varying size, which are soft, freely movable and not tender, are found scattered over the body. The distribution of these nodules does not correspond to nerve distribution. There are pigmented areas upon the back. The patient has mental symptoms and quite severe psychic disturbances. A skin tumor was removed for diagnosis. The diagnosis was neurofibroma (von Recklinghausen's disease).

E. C., white female, aged fifty-six years. This patient has had tumors in the skin of

FIG. 11.—Von Recklinghausen's disease with tumors on deep nerves. These have a symmetrical distribution. The prominence on the posterior part of the arm is caused by a tumor on the radial nerve. This tumor was enucleated, the fibres of the nerve remaining intact.
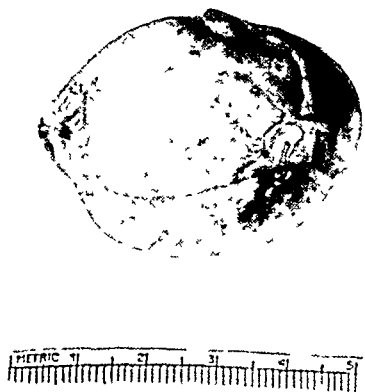
FIG. 12.—Tumor removed from the medan nerve of the patient represented in FIG. 11 This tumor was enucleated. It had a myxo matous appearance on cross-section.

the face and chest as long as she can remember. There are also pigmented areas in the skin which are most marked in the skin of the right upper extremity. A pedunculated tumor the size of an orange hangs from the mid-line of the chest down over the abdominal wall. The base of the pedicle is the size of a half dollar. The pedicle is at least six inches in length. The dependent part of the tumor is ulcerated and anæsthetic. Sensation is present over the base of the tumor. The remaining tumors have appeared at various times, although many were present at birth.

April 27, 1926, the large pedunculated tumor, measuring twenty-seven centimetres in length, was removed by Doctor Cohn. A wide margin of skin and subcutaneous fat was removed with the tumor. On section the tumor was firm, hard and fibrous beneath the ulcer. In other parts it was soft and vascular. The microscopic examinations revealed a fibromyxoma with areas so vascular that the possibility of a hæmangioma was considered.

N. W., white male, aged twenty-six years. Seven years before admission to the hospital the patient had had a growth removed from above the right eye. Two months

after removal the tumor developed again. Five years before a growth had been removed from the right foot and from the chest. Since childhood he had noticed numerous soft, painless nodules over the surface of the body. These, with the exception of the large one which was excised, have given him no trouble.

The patient has the typical appearance of von Recklinghausen's disease. Numerous soft tumors lying in or just beneath the skin are found. July 10, 1920, Dr. Mont Reid removed tumors from the forehead and cheek. The diagnosis of pigmented neurofibromas was made.

The three cases cited above are typical of von Recklinghausen's disease. It is interesting to note the pathological diagnosis which has been made, for not infrequently the myxomatous character of the tumor has been emphasized. In one the vessels were prominent enough to suggest a vascular tumor. The superficial group of tumors has developed from cutaneous nerves.

There are eleven cases in which tumors have been found upon the deep nerves. In four of these malignant changes occurred. Malignant changes in tumors situated upon deep nerves are not at all uncommon in these cases. Garrè, in 1890, directed attention to the tendency for such tumors to become malignant.

G. B., white male, aged twenty-eight years. The patient was first admitted to the medical service in August, 1920. He had tumors distributed over the entire body which had been present since early childhood. The tumor behind his right ear was noted by his mother when he was one year old. New tumors have appeared from time to time. These tumors are circumscribed, grow for a time, become stationary, but do not disappear. They are not painful or tender. In 1918 a tumor behind the right ear was excised and a tumor on the left leg was partially removed. The patient was admitted to the hospital again August 8, 1926, when a small tumor on the left side of the chest was removed. Histologically this tumor was like those found in von Recklinghausen's disease. Recently there has been some stiffness of the left knee and disturbance of function of the left leg. These are due to a large pedunculated tumor which has been present for fifteen years, but recently has grown larger and now hangs down over the knee. Numerous small tumors are scattered over the body. A large boggy tumor mass is found on the anterior aspect of the left thigh which extends from a little below Poupart's ligament to below the knee. The overlying skin is soft and elastic. Palpation of the tumor suggests a fluid wave. The patella is located in this mass of tissue.

October 4, 1926, at operation a large cavity was found in the tumor which communicated with the joint. When this was opened about 800 cubic centimetres of fluid were evacuated. A specimen was taken for examination. The tumor seemed to infiltrate the muscle and was not removed. The patient returned to the hospital again in January, 1929. A large mass had developed in the left half of the pelvis just above Poupart's ligament. On examination a large, hard mass is found in the pelvis and the left lower quadrant of the abdomen. This extends from Poupart's ligament to the umbilicus and causes the abdominal wall to protrude. This tumor is firmly fixed, rises from the pelvis and extends over to the mid-line. The tumor of the left thigh is much smaller than when the patient was here before. January 19, 1929, a biopsy was performed. Part of the tumor was excised without opening the peritoneal cavity. This tumor was firm and fibrous in character.

A diagnosis of spindle-cell sarcoma was made. The patient has been receiving radium treatments. When seen in Baltimore several months after the biopsy the tumor was of about the same size as when the tissue was removed.

E. H., white female, aged fifty years. This patient was operated upon December 1, 1922. Since childhood she had complained of a drawing pain in the left leg and thigh.

She had worn red flannels to relieve this. The leg has been massaged for relief of this pain. Curious pigmented spots and blotches are found over the abdomen and extremities. Since childhood numerous painless, somewhat firm, subcutaneous nodules have been noted over the body. These have increased but slightly in size, and at the present time measure from two to six millimetres in diameter. The pains in her left leg have been more severe during the last ten years. About six years ago she noted that her left hip seemed slightly larger than her right. For the last year she has noticed a definite growth. This tumor was operated upon one year before admission to the hospital and found to be attached to the sciatic nerve. It could not be entirely removed. Since that time it has grown rapidly in spite of radium treatment. The pain has been so severe that narcotics have been required. Hearing in the right ear is
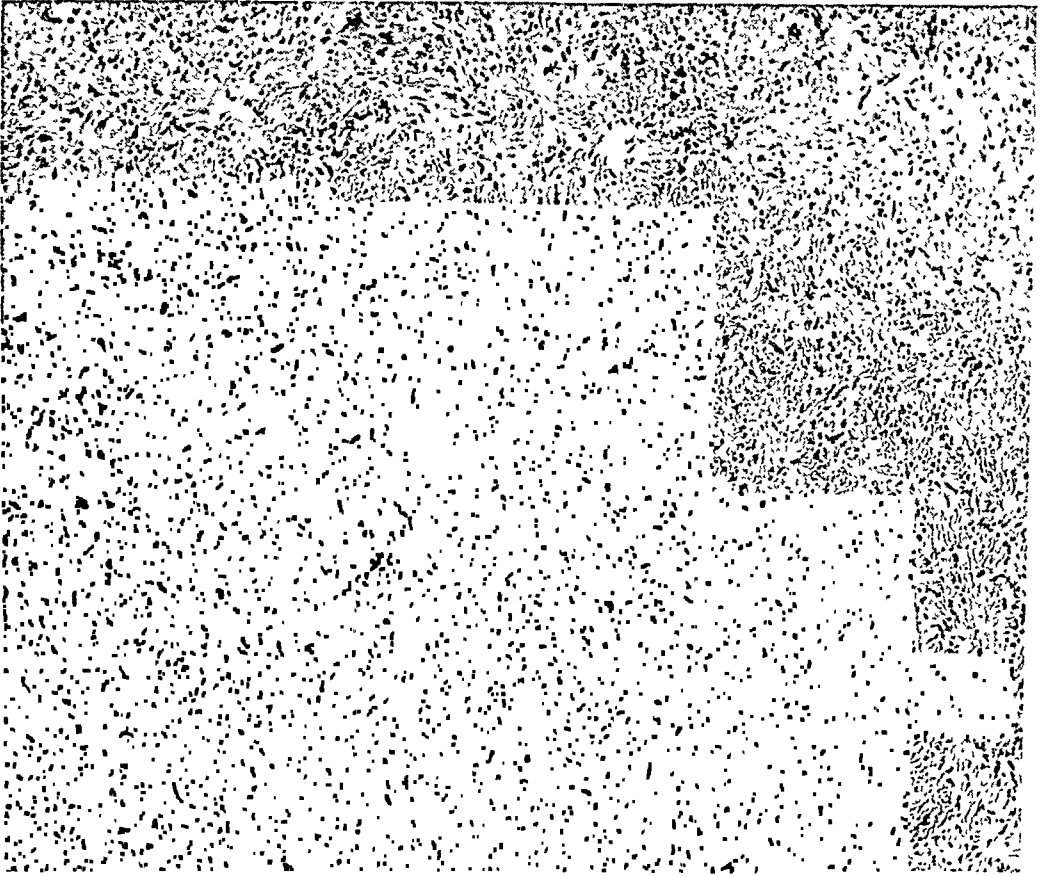
FIG. 13.—Histological preparation of the tumor shown in FIG. 12. This tumor is mixed, containing bands of fibrous tissue. Scattered between these are islands of reticular tissue (type B). These tumors have a decided tendency to undergo malignant (sarcomatous) changes.

impaired and at times the patient complains of numbness of the right side of the face. The patient has evidently lost weight recently. The tumor on the left thigh is about the size of a football, measuring twenty-four by eighteen centimetres. Over this is a scar twenty centimetres long. There is no muscular weakness in the left leg. The skin over the body has a mottled appearance. The pigmented areas, varying in size from a pinhead to a silver dollar, are irregularly distributed. The possibility of a tumor on the eighth nerve was considered because of the impairment of hearing.

December 1, 1922, the tumor in the thigh was removed. It apparently rose from the great sciatic nerve. Only a partial removal was possible. When the tumor was cut across it had a lobulated, yellowish, pearl-gray appearance. The patient was a poor operative risk and died a few hours after the operation.

Pathological diagnosis.—Spindle-cell sarcoma with extensive necrosis and degeneration. Malignant degeneration of a tumor in von Recklinghausen's disease.

The following are cases of von Recklinghausen's disease with tumors of deep nerves without malignant changes. The specimens which were removed illustrate especially well the histology of these growths and how they differ from that of the solitary tumor.

E. R., white male, aged twenty-one years, was admitted to the Johns Hopkins Hospital October 10, 1927. The patient has small tumors scattered over the body, most of which correspond to the course of superficial nerves. He came to the hospital especially because of symptoms associated with a tumor over the course of the left musculospiral nerve, located where the nerve is in the radial groove. Numerous well-circumscribed tumors of various sizes, from a small shot up to a small orange, are scattered over the body. The greater number of nodules are about the size of a pecan. Practically all are superficial, firm and rubbery in consistency, and, in general, follow the course of superficial nerves. In the left arm along the course of the radial nerve in the radial groove is a fusiform tumor, constricted at the middle. Pressure on this causes a tingling sensation over the distribution of the radial nerve. Pigmented areas are scattered over the body.

At operation, October 10, 1927, a tumor was found upon the radial nerve. The tumor was removed by splitting the nerve, the fibres of which seemed to form a capsule about it. The tumor was shelled out of the nerve. The pathological diagnosis was neurofibroma. The patient returned in March, 1930, with a large tumor on the median nerve of the right side just below the axilla. This tumor was removed by separating the fibres of the nerve and shelling it out. This tumor was more myxomatous in character than the tumor previously removed from the musculospiral nerve. Neither tumor has recurred. It should be remembered, however, but a short time has elapsed since their removal.

The following cases, which might be included under the term Ranken neurom, have been characterized by multiple growths upon the nerves of an extremity associated with an increase in size of all the tissues of the extremity.

· R. R. is a female child, aged four years. About sixteen months before operation, September 28, 1928, a general eruption resembling insect bites appeared upon the body. This eruption appeared from time to time. It was noticed then that the left leg and thigh were larger than the right. The enlargement involved the leg, thigh and half of the pelvis on the left side. Thirteen months before admission small, tender, subcutaneous nodules appeared about the upper end of the fibula. The child has not complained of pain, but she favors the right leg somewhat. The nodules have increased somewhat in size. The left lower extremity is distinctly larger than the right and has none of the changes associated with a lymphœdema. The hypertrophy involves all the tissues from the gluteal muscles to the tips of the toes. Muscle power is not reduced. There is no limitation of motion, no spasticity nor pain. There is some eversion of the left foot. Near the left knee and ankle both medially and laterally there are firm, discrete masses which have a linear distribution and are apparently connected with nerves. These are especially well marked posterior to the medial malleolus. All the other parts of the body are normal.

Some of the nodules along the posterior tibial nerve were removed for study. A pathological diagnosis of neurofibroma was made.

The following case has been reported by Dr. Willis Campbell:

A. E., a white child, aged fourteen years, has the following history. When the patient was one and a half years old the mother noted that the right ankle and foot were larger than the left. Shortly after that it was noted that the entire extremity was larger. This relative difference in size has been maintained. Examination shows a healthy girl of fourteen with no abnormality except in the right lower extremity. This extremity is enlarged, being increased in length and circumference. Deformity at both the knee- and ankle-joints is noted. The patient walks with difficulty as the weight is transmitted onto the dorsum of a club-foot. The extremity has many diffuse, lobulated

FIG. 14.—Von Recklinghausen's disease. Multiple tumors arising from the dura (Dandy).

tumors beneath the deep fascia which are differentiated with difficulty from the muscles. These cylindrical masses are from one to two inches in diameter. These masses are tender. Measurements show that the right thigh is four inches larger than the left, and the right calf three inches larger than the left. The right lower extremity is five and a half inches longer than the left. Muscle power in the right leg is not impaired. X-ray of the right lower extremity shows that the bones are increased in length, decreased in diameter and atrophic.

Doctor Campbell, by repeated operations, removed numerous lobulated tumors. The

leg was considerably diminished in size. The femur was shortened and the ankle stabilized by removing the astragalus. The lower epiphysis of the tibia and fibula were destroyed, as it was thought that abnormal growth from other parts would counterbalance the effect of epiphyseal destruction. After four operations on the soft parts and two on the skeleton the extremities were of equal length, but the right leg was greater in diameter than the left by one inch.

The pathological report is as follows: The section shows loose tissue composed of strands with few nuclei. There is much homogeneous material which resembles coagulated lymph between the cells. One pathologist reported that he identified nerves in the growth.

These six cases represent different clinical manifestations of the same disease: the cutaneous form of von Recklinghausen's disease, a form associated with tumors upon the deep nerves in which there is a decided tendency for sarcomatous degeneration of the tumor, and a form localized to an extremity which becomes enlarged and to which the term of elephantiasis nervorum might properly be applied, although this term has been applied to other lesions of this type other than the two last described.

Elephantiasis Nervorum.—Bruns, in 1891, published an article upon Rankenneurom in which he states that this tumor is one of the rarest and most peculiar. Two of the first cases were observed by Depaul, in 1857, and Guersant, in 1859. These were carefully studied by Verneuil. Two were reported by Billroth, in 1863 and 1869. Bruns states that the greatest interest attaches to the origin of these tumors and their relation to other nerve tumors. According to him this is a form of congenital elephantiasis; if by this term is understood a congenital anlage leading to tumor-like connective-tissue growths which may affect skin and subcutaneous tissues, sometimes the blood-vessels, the lymphatic vessels and nerves (elephantiasis telangiectodes, lymphangiectodes, neuromatodes). Bruns grouped under the term elephantiasis nervorum—generalized neurofibromatosis—the cases in which the tumor involved a limited area of distribution of the nerve (Rankenneurom), and those cases in which the changes involved the ends of the cutaneous nerve (fibromata mollusca). The localized forms differ in extent, not in nature, from the generalized.

Garrè has pointed out the tendency of tumors in neurofibromatosis to become malignant. Malignant degeneration occurs in at least 12 per cent. In the cases reported by us, although the series is too small to permit of definite conclusions, malignant degeneration has occurred in 50 per cent. There are many transitions between the benign and malignant growth, so that it is difficult to determine at times where benignancy ends and malignancy begins. In Garrè's case ciliated epithelium was found, suggesting a teratoma. This brings up the question of possible development of these cells from the sheath of Schwann. Cohn has reported epithelial tumors in peripheral nerves which probably have developed from the sheath cell.

Trauma and operative interference may predispose to malignant changes, and the possibility of such a change occurring after partial removal of one of these growths should always be considered. This group of connective tissue

growths differs from the group of benign tumors first described, in which there is little, if any,˙ tendency to malignant changes. Virchow recognized the tumors occurring in von Recklinghausen's disease as due to an overgrowth of connective tissue. Wood, Smith and von Recklinghausen also recognized the connective tissue origin of these tumors. Penfield states that a pure neuromfibroma in one sense is not a neoplasm at all. There are wandering nerve fibres derived from the involved nerve and a surrounding tangle of reactionary connective tissue which is a magnification of the widespread alteration of the nerves in this systemic disease. Confusion arises from the fact that at times within these neurofibromata, perineurial fibroblastomata may appear and may grow so large as to displace most of the neurofibroma tissue to the periphery. In the case of von Recklinghausen's disease, however, nerve fibres will be found to enter each tumor, with few exceptions; while in the solitary perineurial fibroblasto-

FIG. 15.—Elephantiasis nervorum. The left lower extremity is enlarged. Multiple nodules can be palpated over the nerves. These are especially marked over the short saphenous nerve.
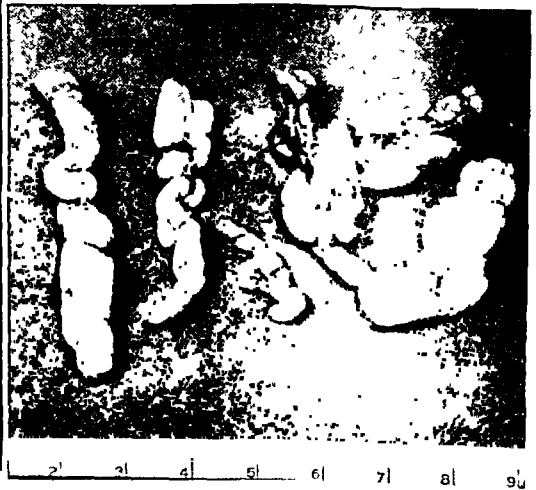
FIG. 16.—These tumors were removed from the posterior tibial nerve just behind the internal malleolus in patient represented in Fig. 15.

mata, the comparatively normal nerve is invariably applied to the capsule of the tumor without penetrating it.

This last statement is undoubtedly subject to exceptions, for, if it were so, all neurinomas could be enucleated. In one of our cases, a typical neurinoma, resection of the sciatic nerve was necessary because the tumor was penetrated by funiculi, and in another some fibres of the internal popliteal had to be sacrificed.

In the neurofibromas of von Recklinghausen's disease the tissue is mixed. This can be seen readily in studying sections. Many of the tumors may be pure fibromas. In the multiple neurofibromas the neurinomatous tissue is the loose, delicate, reticular type (type B). The centrally located tumors occurring in von Recklinghausen's disease may be composed entirely of neurinomatous tissue. This accounts for the relative frequency with which central degenerative changes occur in these.

The solitary tumor and the multiple tumor of von Recklinghausen's disease differ histologically. Clinically, we are justified in concluding that there is a great difference as regards the possibility of malignancy between the solitary tumor and the multiple tumor of neurofibromatosis. There is also a great difference in the histology. A peripheral nerve is a complicated structure composed of highly differentiated epithelial and connective tissue elements, which in their growth may give rise to specific and characteristic structures. The sheath of Schwann may, in tumor formation, give rise to a growth distinctly epithelial in character. This change probably accounts for the epithelial tumors in peripheral nerves recently reported by Cohn, and the ciliated epithelium observed by Garrè in a malignant tumor occurring in von Recklinghausen's disease.

Sarcomas.—In this group are four tumors. The histories of these will be given. Two illustrate the mode of extension of a sarcoma, and one the possibility of at least a long period of freedom from recurrence following operation.

T. M., white male, aged fifteen years, noticed pain December 15, 1928, just above the knee along the hamstring muscles. A tumor about the diameter of a twenty-five-cent piece appeared later in the region where the pain was first experienced. The tumor was aspirated but nothing was obtained. An operation, the nature of which cannot be ascertained, was performed March 14, 1929. The patient remained in the hospital two weeks. Since then the patient has complained of numbness of the leg. An examination made upon June 7, 1929, showed that the right leg was flexed at the knee. A long scar is noted on the posterior surface of the thigh. The right thigh is larger than the left, and in the region of the scar over the posterior part of the right thigh is a movable mass. It is impossible to say whether this is the original tumor or a recurrence. An X-ray examination revealed a large, soft-part tumor which extended along the course of the sciatic nerve well up into the gluteal region. There were no evidences of metastases in the chest.

Doctor Bloodgood believed that the tumor developed from the sciatic nerve and that an amputation of the thigh should be performed.

The tumor was adherent to the muscles, quite myxomatous and œdematous. Small tumors were found on the branches of the sciatic nerve. Some of the tumor mass extended beyond the sciatic notch, rendering complete removal impossible.

The branches of the sciatic nerve below the popliteal space were covered with white, smooth, myxomatous masses. The large, and probably the original, tumor has many necrotic, hæmorrhagic areas. The pathological diagnosis was fibromyxosarcoma of the sciatic nerve.

The second case illustrates again the tendency of a sarcoma to extend along the nerve.

M. M., white male, aged forty-one years, noted in 1910 a hard nodule in the lower lip. This did not ulcerate. It was enucleated. Since this first enucleation the tumor

has recurred and has been removed fifteen times. The last operation was performed in June, 1915. No ulcer had formed. The cervical lymph nodes had not been removed. X-ray treatments had been given at various times for five years.

A histological study of the tissues which had been removed at previous operations revealed a cellular tumor composed of spindle and round cells. In some sections nerve tissue was found in the tumor. The tumor was thought to be multiple neurofibroma.

September 10, 1915, Doctor Bloodgood removed the lower jaw and submaxillary glands. The inferior dental was as large as a thumb. The tumor extended up to the point at which the nerve emerges from the skull. This point was cauterized. Histological examination revealed much the same picture as that of the tissue previously removed. The cells were, however, larger and more irregular in size.

The patient died January 26, 1916, with cerebral symptoms, apparently due to an
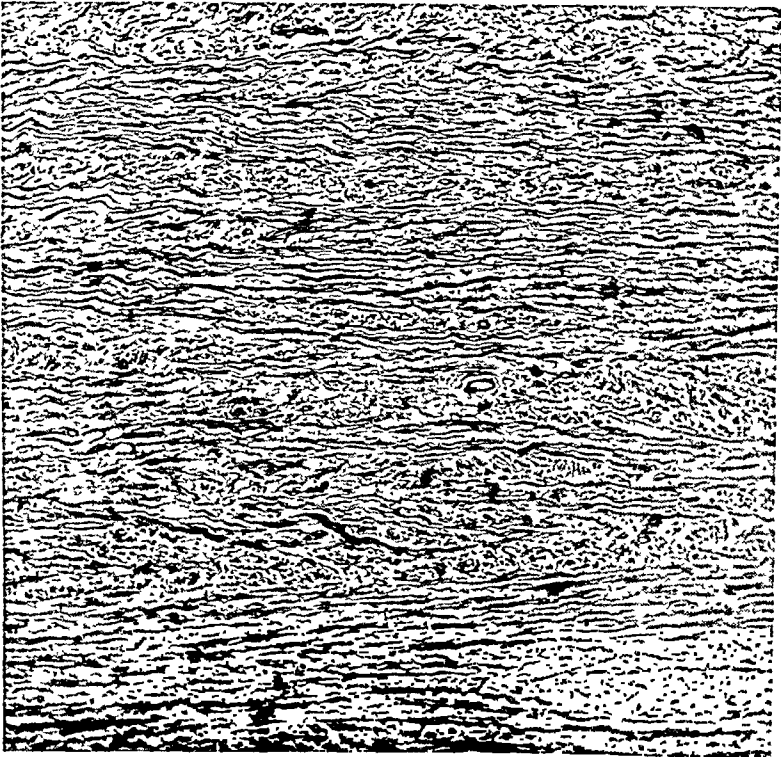
Fig. 17.—Histological preparation of the tumors shown in Fig. 16. The histology differs markedly from that of the solitary tumor (neurinoma) of peripheral nerves.

extension of the growth to the cranial cavity. This tumor, regarded at one time as a multiple neurofibroma, was undoubtedly malignant, as indicated by the number of recurrences in the lip and final extension to the skull.

A third sarcoma involved the internal popliteal nerve on the left side. The nerve was resected. Seven months after operation there was a recurrence, and a little over five years after the first operation the patient died. A diagnosis of round-cell sarcoma was made.

Dr. Miles F. Porter has kindly furnished us with the history of a case in which a tumor developed in the upper third of the thigh posteriorly in a female patient aged fifty-two years. This tumor caused pain which radiated down to the ankle and up to the hip. A tumor was removed in August, 1923. Six months later another tumor was removed. This was situated a few inches above the original tumor. Seven months later the tumor recurred and was removed again. During one and three-quarter years this tumor recurred frequently.

On July 2, 1923, Doctor Porter operated and removed an encapsulated tumor the size of a small orange from the muscles on the posterior surface of the thigh. A diagnosis of sarcoma was made from frozen sections. The bed of the tumor was cauterized (actual cautery) and alcohol applied to the wound surface.

Subsequently, after many recurrences the sciatic nerve with a tumor was resected and a fascial tubulization performed. Five years later the patient reported that there had been no recurrence of the tumor. Some foot drop persisted and there were sensory changes associated with resection of the sciatic nerve. It is impossible to determine the origin of this tumor, but eventually it involved the sciatic nerve, necessitating its resection. It may have arisen primarily in one of the branches of the sciatic, and secondarily have invaded the main trunk.

Sarcomas of peripheral nerves, as already stated, are extremely malignant and tend to form metastases along the nerve primarily involved. They may, however, extend to other nerves in the extremity, passing to these apparently along branches communicating with the nerves primarily involved.

Two rather unusual tumors were encountered in this series, one arising apparently from the cervical sympathetic, the other from the vagus.

Tumor of the Cervical Sympathetic.—G. N., white male, aged forty-one years, had a small mass on the left side, about the middle of the neck, for eighteen years. At first this was about the size of a cherry. It gradually increased in size, but it has not increased in size any more rapidly of late. There has been no pain. There has been no difficulty in swallowing until recently, when there is a slight sensation of pressure on swallowing and occasionally on breathing.

Examination reveals a tumor on the left side of the neck. It is elliptical and fills practically the entire space between the angle of the jaw and the clavicle. It has displaced the trachea and the carotid artery to the right side. The carotid artery has been displaced so far forward and to the right that it can be seen beating almost in the midline of the neck. There is no difference in the pupils on either side. They react normally to light and accommodation.

This tumor could be easily removed. The carotid artery was in front and median to the tumor, the jugular vein and the vagus nerve were in front and to the outside. The most probable origin of this tumor seemed to be the cervical sympathetic trunk. The tumor had little vascular supply and was easily separated from the surrounding structures. The histology of this tumor is represented in Fig. 19. As will be seen, the tumor contains a large number of ganglion cells.

Tumor of the Right Vagus Nerve.—The other tumor in this group arose from the right vagus nerve. Because of the pigmented areas in the skin it is quite possible that this tumor belongs to the von Recklinghausen group. There were no other palpable tumors in this case.

The patient, a white male, was nineteen years old. Five years ago he noticed for the first time a small mass behind the right mandible. This caused no pain. Four years ago the mass became larger, and a doctor advised that the tonsils be removed. Later a diagnosis of tuberculous glands was made.

Examination reveals a mass on the right side of the neck. It fills the space between the angle of the jaw and the mastoid, and occupies the upper half of the neck posteriorly. The tumor is the size of a man's fist. The skin over it is freely movable. The surface of the tumor is smooth, with no signs of lobulation. It is sharply delimited from the other structures in the neck. The common carotid artery is anterior to the tumor. The trachea is displaced to the left. There are no pupillary changes which would suggest connection with the cervical sympathetic.

The tumor is apparently fixed by neighboring structures. Von Recklinghausen's disease, a brachial cyst, and carotid body tumor were considered in the differential

diagnosis. This tumor when removed was found to be a fibromyxoma of the vagus nerve. Following removal of the tumor the patient was unable to swallow anything but soft foods and liquids. He strangled when he attempted to swallow. The symptoms which he complained of following operation were due to loss of function of the right superior and recurrent laryngeal nerves.

This case, in view of the marked pigmentation, should probably be regarded as an example of von Recklinghausen's disease. The only palpable tumor developed upon the right vagus nerve. The patient with the tumor of the cervical sympathetic died one year and four months after operation. There was a local recurrence and pulmonary metastases. It has been impossible to trace the patient with the tumor of the vagus. He returned to the hospital six months after having been discharged, and to that time the signs and symptoms associated with paralysis of the vagus persisted.

FIG. 18A.—Tumor on the sciatic nerve in a case of von Recklinghausen's disease.
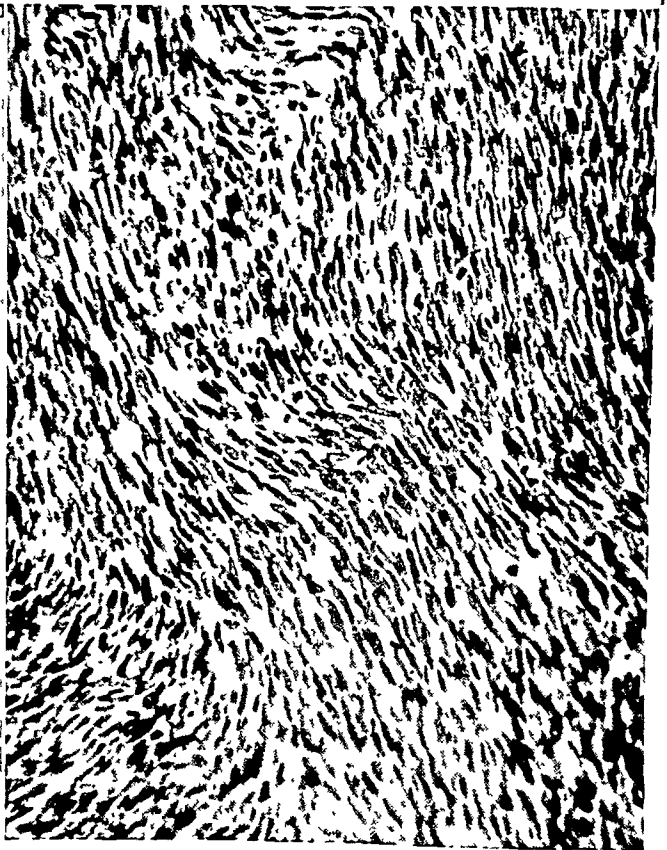
FIG. 18B.—Histological preparation of a recurrent tumor in the patient shown in Fig. 18A. Malignant change in a tumor of von Recklinghausen's disease.

Neurofibromatosis Confined to the Skin, Localized in Extent (Fibroma Molluscum).—R. L., white male, aged twenty years, was operated upon April 10, 1907. The patient stated that since birth a small tumor had been present on the internal surface of the right foot just below the malleolus. This has gradually increased in size, and other tumors have appeared on the internal portion of the plantar surface of the foot. When the patient was thirteen years old the tumors were excised, but in about six weeks others developed. These have increased in number and size until at the present time the entire internal part of the plantar surface of the right foot and great toe are covered with tumors.

On the inner side of the sole of the right foot and great toe are peculiar pedunculated, soft tumors which are more or less separated from each other. They, however, lie side by side and seem to be almost continuous. They are flattened out by the pres-

sure exerted when the patient is standing. In gross appearance they look very much like fibromata mollusca but do not seem to follow the distribution of any one nerve.

On April 10, 1907, the tumors on the inner side of the plantar surface of the foot were excised, as little skin of the pedicle as possible being removed. The skin was brought together with interrupted sutures of fine silk except in two places, which were allowed to granulate. Eleven years after this the patient reported that there had been no recurrence of these tumors.

The clinical manifestations of different varieties of peripheral nerve tumors have been discussed. An attempt will be made to correlate clinical manifestations and prognosis with histological findings. A peripheral nerve has a complicated structure, being composed of neurofibrillæ, the myelin sheath, the sheath of Schwann and connective tissues surrounding the fibres, funiculi, and nerve. Judging from a study of the tumors in this series and from cases which have been reported, the neurofibrillæ take no part in tumor formation.

Fifteen solitary tumors of peripheral nerves have been described. These have not recurred following operation, and in all but one case the tumor could be enucleated. In one case a large tumor of the sciatic nerve was found. This could not be enucleated because the nerve fibres ran through it. Almost two years after resection and suture there has been no recurrence of the tumor.

These tumors are composed of the neurinomatous tissue described by Verocay. They contain islands or whorls of type A tissue, which is characterized by nuclear palisades. They resemble histologically the acusticus tumor and the tumors developing upon spinal nerve roots, most frequently upon the posterior roots. Degenerative changes, occurring most often in the reticular tissue, may cause the myxomatous appearance of the tumor which is so common.

Lhermitte and others have recently suggested that these tumors characterized by palisading of the nuclei developed from the sheath of Schwann cells, the lemmocyte, and classified them as gliomata. Verocay was the first to suggest such an origin. Penfield states that the fibres produced in these neoplasms show that the type cell bears no relation to neuroglia nor to the ectodermal sheath of Schwann. The histological picture is characterized by palisading and parallelism of the nuclei and a tendency to form nuclear eddies and streams. The fibres are typically long, slender, wire-like, and arranged parallel to each other. These fibres resemble the connective tissue seen in normal nerves where they run parallel to nerve fibres. The term perineurial fibroblastoma has been given to these tumors by Mallory. Clinically thy are benign tumors which, as a rule, can be enucleated from the nerve, leaving the greater part of it intact.

The tumors occurring in von Recklinghausen's disease were described by Verocay as mixed. They were shown by him to be composed of neurinomatous tissue and connective tissue. The nearer the periphery the tumor is located, the more the fibrous tissue predominates. The tumors occurring in von Recklinghausen's disease frequently undergo secondary changes. Such

changes are indicated in the tumor represented in Fig. 18B. This tumor had a decidedly myxomatous character. These tumors are apt to undergo sarcomatous changes. This tendency has been frequently noted, and in the series herein reported, though small, malignant changes occurred in 50 per cent. of the cases. Penfield states that in retaining for the tumors of von Recklinghausen's disease the time-honored name of neurofibroma, the term must be understood to signify a tumor which contains both nerve fibres and connective tissue. It is not a new growth of nervous tissue, although there are nerve fibres and apparently new nerve collaterals running in it. It is not
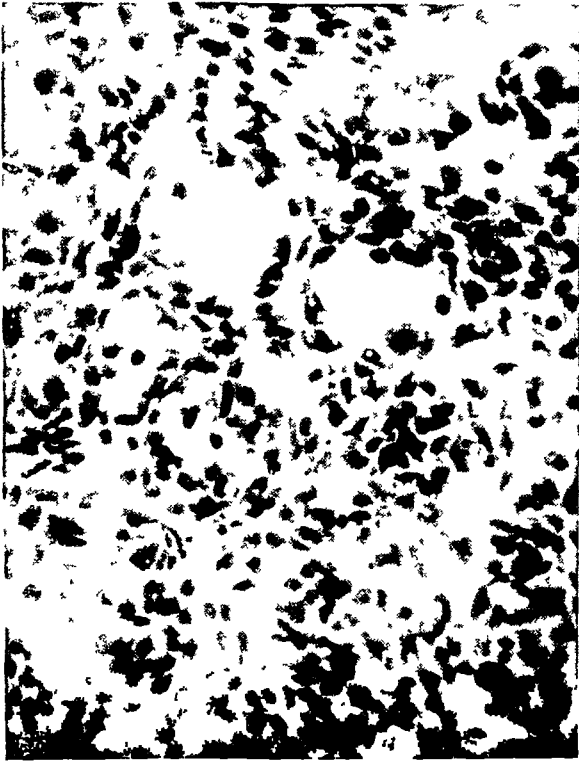
Fig 19 —Histological preparation of tumor developing from the cervical sympathetic containing ganglion cells This tumor was malignant It recurred locally within a few months after removal, and formed metastatic growths in the lungs

Fig 20 —Neurofibroma of the right vagus nerve Diagnosis of this tumor was suggested by pigmentation of the skin No other tumors palpable on deep nerves Paralysis of fibres of the vagus followed removal of the tumor.

a simple fibroma but a connective tissue reaction that is part of a more general process.

In the tumors situated peripherally the neurinomatous or fibroblastomatous tissue may be suppressed by an overgrowth of fibrous tissue, a fibroma then being found. Whether the masses occurring upon the nerves in von Recklinghausen's disease should be regarded as tumors or merely as a connective tissue reaction to an irritant may be a disputed question. Clinically, they appear as tumors with a decided tendency to undergo sarcomatous changes.

These growths may be confined to the nerves of an extremity. All the tissues of such an extremity may be affected, resulting in a decided increase

in length and circumference unaccompanied by pigmentation of the skin or any appearance suggestive of a lobulated elephantiasis.

The one case of a tumor developing from the cervical sympathetic is of interest because of the relatively early recurrence of the tumor and the formation of metastases to the lung.

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PENETRATING TO THE GASSERIAN GANGLION*

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As INTRODUCTION, a short review of the methods concerning this matter may serve. The method of Härtel-Schlösser enables one to reach as well into the third branch of the trigeminus nerve as into the Gasserian ganglion. His method consists in penetrating with the needle between the ascending branch of the lower jaw and the protuberance of the upper jaw into the oval orifice and the Gasserian ganglion. In using Härtel's method, the surgeon sits down in front of the patient, with the needle in his right hand; he pricks, after the necessary anæsthesia, the skin of the cheek on the level of the second upper molar tooth, and he introduces the forefinger of the left hand into the mouth of the patient in order to prevent the possibility of penetrating with the needle into the cavity of the mouth. The needle is ten centimetres long and 0.8 millimetre thick.

First of all, putting the "bar" of the needle at a six-centimetre distance from the point, one advances the latter upward and backward into the fossa infratemporalis in such a manner as to penetrate into the interspace of the ascending branch of the lower jaw and the protuberance of the upper jaw. If the surgeon faces the patient from the front, the direction of the needle has to coincide with the pupil of the corresponding side; if looked at from the side, the prolonged axis of the needle has to point to the articular tubercle of the temporal bone. After the needle has passed six centimetres in depth, that is,. as far as the oval orifice, the "bar" has to be advanced at one and one-half centimetres; that is, the distance necessary to let pass the needle from the oval orifice to the Gasserian ganglion. As soon as the needle-point has reached the oval orifice, a pain will be felt by the patient in the region innervated by the third branch. While introducing the needle-point into the ganglion the surgeon injects very slowly the medicated solution, whereafter complete anæsthesia sets in.

Härtel observed that the oval orifice presents a canal the axis of which coincides with that of the fore-plane of the pyramid of the temporal bone; the axis is continued between the ascending branch of the lower and the protuberance of the upper jaw and crosses the second upper molar tooth. In some cases, the axis has so changed that it crosses not the second but the first or the third molar tooth. Sometimes it occurs that the needle-point introduced on the level of the second molar does not reach the oval orifice. That depends on the height of the upper jaw. In such cases the surgeon has to introduce the needle before or behind the second molar tooth.

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* Read before the Russian Surgical Congress, 1929.

In some cases, the axis of the oval orifice will not coincide with that of the pyramid of the temporal bone. In this case the needle will penetrate into the temporal part of the brain instead of the Gasserian ganglion.

In the literature there have been described cases of purulent meningitis when the needle was introduced following Härtel's method. Probably this was occasioned by technical failure.

With regard to their neighborhood the following vessels can be injured: art. carotis int., art. mening. media, bulbus ven. jugularis, and sometimes also the art. maxill. int. Härtel, experimenting on many cadavers, in some cases pricked the fossa jugularis; in some cases, too, the eustachian tube.

The size of the oval orifice is of absolute importance for reaching into the Gasserian ganglion. Härtel, after measuring, fixed the length of the former at five to eleven millimetres, and the width of it at two to seven and one-half millimetres. If the width is less than three millimetres, Härtel, considers it as impossible to penetrate into the ganglion. Härtel, after measuring fifty-eight skulls, found that the distance between the oval orifice and the upper margin of the pyramid of the temporal bone varies between nineteen and twenty-three millimetres, the minimal distance being fourteen millimetres. Thus, he proposed, after penetrating into the oval orifice, to advance the needle not higher than at fifteen millimetres, in order to avoid a possible penetration of the needle-point into the cisterna pontis and a wounding of the upper sinus petrosus. Härtel advises, too, to follow the movements of the eyes and the pupils during the injection for prevention of a possible influence of the alcohol on the occulomotorius and abducens nerves of the eye-muscles. The injection must be stopped as soon as dilatation of the pupils and deranged abduction of the eyes are visible. Not seldom after injections into the Gasserian ganglion, keratitis has been noticed.

POLOZOF noticed this complication in the case of a broad oval orifice, whereby the needle was able to easily glide into the skull; anæsthesia of all the three branches of the trigeminus nerve supervened.

Many authors have observed that the eustachian tube was damaged— the alcohol had penetrated into the throat. MALKIN has described a case when the patient lost his hearing and sight from injecting alcohol after the method of Härtel. NEUGEBAUER mentioned a case of wounding the carotis interna. In the latter case the alcohol had been injected in spite of blood aspiration by the needle-point, and amaurosis supervened.

PUSSEN has not noticed a severe wounding of the vessels in the case of delivering the injection into the nerve trunks or the ganglion: by using a slender needle it does not pierce the vessels. and, even if piercing did occur, the wounding would be of the least degree.

To be sure that the needle-point has attained the Gasserian ganglion, first of all one has to administrate an injection—that of one cubic centimetre of a 4 per cent. novocaine-suprarenin solution—and only after the anæsthesia has supervened, is it allowed to inject one-half to one cubic centimetre of 90 per cent. alcohol.

Lexer, Brown, and other authors, in most of the cases administered the injection under a general narcosis on account of the increased sensibility of the skull base in case of trigeminal neuralgia and the necessity of operating on the patient when he is in a state of absolute patience and calm. Kulenkampf advises to administer the injection while the surgeon is still not tired; he administered the whole injection in fifteen to twenty minutes.

Sometimes, during the injection of novocaine into the Gasserian ganglion, it reached the subarachnoidal space, provoking somnolence, headache, and vomiting. The alcohol injection is sometimes complicated by cyanosis, slowing of the pulse-rate and headache.

Most authors insist upon the necessity of administering the alcohol injection in a hospital.

Härtel fixed the following indications of treating the trigeminal neuralgia by alcohol injections:

1. Recent cases of neuralgia of the fifth pair have to be treated by purgatives and hot-air apparatus after the method of Bier and especially by massage. Peripheric and central novocaine injections are successful too.

2. Chronic cases with localization in single branches should be treated by peripheric alcohol injections after the method of Schlösser or by injections into the skull base.

3. Severe and relapsed cases after peripheric injections must be treated by intracranial injections into the Gasserian ganglion. These injections must be repeated till a permanent anæsthesia has supervened.

4. Resection of the Gasserian ganglion is indicated in cases of failure in spite of repeated intracranial injections, and in those, when frequently undertaken punctures of the oval foramen do not succeed on account of anatomical conditions.

5. Peripheric and central alcohol injections are indicated in cases of repeated neuralgias caused by inoperable tumors.

Härtel himself considers his method as a technically difficult one, demanding careful exercises on the cadavers.

All the above-mentioned data demonstrate that penetration into the Gasserian ganglion after the method of Härtel is a serious operation.

Offerhaus, too, in 1910, proposed a method of reaching the Gasserian ganglion. It consists essentially in introducing the needle, bent to a 130° angle, behind the last molar tooth, near the hamulus pterygoideus; then the needle has to be advanced along the median plane of the lateral plate of the pterygoid apophysis to the oval orifice. Not mentioning infection, which this method could always involve, there is the inconvenience of the contortion of "hamuli pterygoidei" and the irregularity of form of the lateral plate of the pterygoid apophysis, which may hinder the penetrating into the Gasserian ganglion.

The method of penetrating into the Gasserian ganglion through the foramen rotundum is not popular on account of its technical difficulty.

The method of Harris consists essentially in penetrating into the oval

orifice through the incisura mandibularis. One introduces the needle in a horizontal direction on a line joining the incisura intertragica of the ear conch with the nose wing in a three-centimetre distance before the incision. In some cases the needle strikes against the ascending branch of the lower jaw. In order to avoid that, one has to drop a bit the outward end of the needle, after which the latter passes easily through the incision of the lower jaw on the lowest level of it. Directed a little backwards, the needle strikes at a three-centimetre depth against the lower plane of the large wing of the sphenoid bone; advanced thereafter in the depth of a four to four and one-half-centimetre distance from the skin, the needle reaches the third branch of the trigeminus nerve. This method must be considered as an inconvenient one, because following one introduces the needle blindly without corresponding measuring. Besides, following this method we cannot change as we like the directions of the needle for it traverses the firm fascia and muscles and we risk wounding the art. mening. med., and art. maxill. int. After this method, even if the needle reaches into the oval orifice, when advanced, it must wound the cavernous sinus.

ROMANZEW described five cases of alcohol injections into the Gasserian ganglion after the method of Meyer. With a head-side position of the patient, one introduces the needle through the incision of the lower jaw perpendicularly into the depth. After one has passed the adipose tissue clothing the internal upper jaw artery and external pterygoid muscle, one reaches the external plate of the pterygoid apophysis of the sphenoid bone. Just behind the angle formed by the free margin of the plate with the base of the skull, nearly on the same level as that of the plate, is the oval orifice. While the mouth of the patient is tightly closed, one introduces the needle along the back margin of the top of the coronoid apophysis of the lower jaw which is to be found previously, then one advances the needle along this margin vertically into the depth, closely hugging the back margin of the plate. Gliding on the latter one manages to direct the needle a little backward, until the contact with the bone is lost, after which we turn the point of the needle towards the skull base and advance it one to two centimetres deeper in. The needle strikes against the internal margin of the oval orifice, where the fluid may be injected.

The above-described method is a modification of that of Harris. The inconvenience of this method as well as that of Harris is, as mentioned, the danger of wounding the upper jaw artery and the impossibility previously of fixing the depth of the puncture.

In opposition to the method of Härtel, we are penetrating into the Gasserian ganglion from below, i.e., inwardly from the angle of the lower jaw.

OFFERHAUS remarked in his day that the oval orifices and the articular tubercles were on a same line. Uniting by direct lines the angle of the lower jaw, the upper margin of the articular tubercle, and the oval orifice, we get an *isosceles* triangle with the top at the angle of the lower jaw. Consequently, the distance from the angle of the lower jaw to the oval orifice,

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will be equal to the distance from the former to the upper margin of the articular tubercle. The examination of fifty skulls has enabled us to affirm that our deductions are quite true. Now, as it is quite easy to determine in everyone the distance from the angle of the lower jaw to the upper margin of the articular tubercle, so one can calculate *a priori* the depth from the puncture of the needle to the oval orifice. Our examinations proved that the maximal possible failure equals one to two millimetres, which is of no real importance. The arithmetical average of the distance to find equals 6.4 centimetres as determined by the examination of fifty skulls.

In this method of ours as compared with that of Härtel we can in nearly every case beforehand fix the distance from the angle of the lower jaw to the oval orifice, while following the method of Hartel there are no points
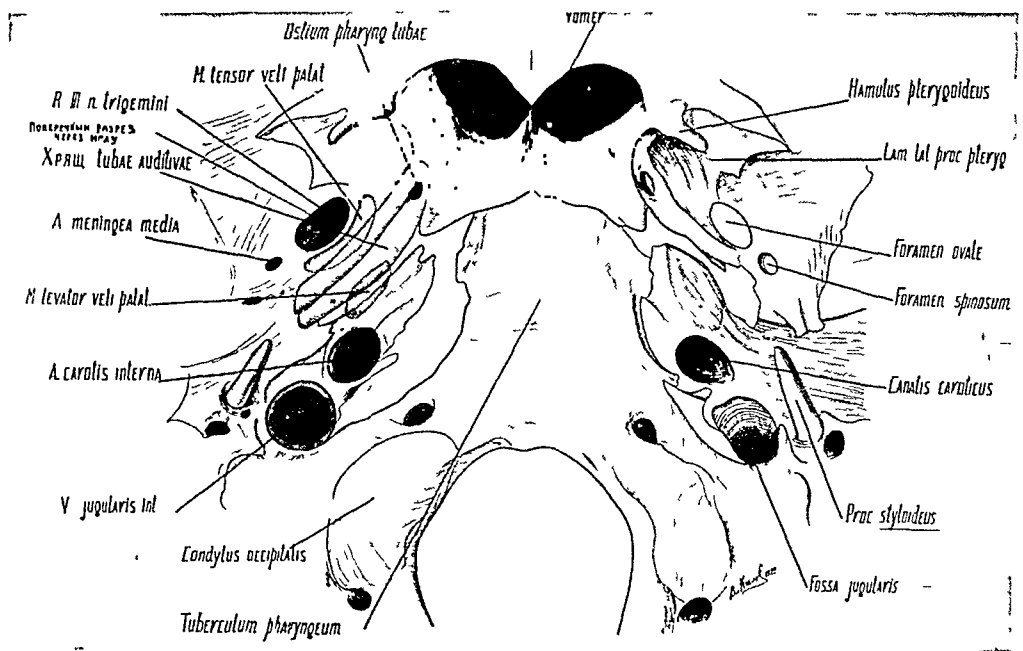
Fig 1.—Relation of important structures to the skull base anterior to the foramen magnum.

to rely upon for measuring the distance from the initial point to the oval orifice. After Härtel, the arithmetical average equals five to seven centimetres. The variability of that distance is, of course, considerable, and depends upon the skull form. The oval orifice and articular tubercles being on the same line, the prolonged direction of the needle from the point of puncture on the angle of the lower jaw must coincide with the line uniting the latter with the upper margin of the articular tubercle. We have elaborated this method on cadavers but at the moment of this publication we are not able to verify it on patients.

The technic of penetrating into the Gasserian ganglion after our method is the following: (Figs. 1, 2, and 3)

The patient is lying upon the table for operation, his head hanging downward after the method of Rose—his head is fixed by an assistant.

Fig. 2 — Horizontal cut of the skull at the level of the atlas

Tonsilla palatina

M. masseter

Mandibula

A. et n. alveolar inferior

N. facialis

Gl. parotis

A. carotis ext

V. facialis post

Fascia parotidea

V. jugularis int n n IX

FIG. 3 — Dissection showing the course of the fifth cranial nerve and its branches demonstrating the method of the needle in penetrating to the Gasserian ganglion by the methods of Hartel and of Irger, respectively.

Härtel's method

Irger's method

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One previously marks by a little damp bar of silver nitrate the line joining the upper margin of the articular tubercle with the angle of the lower jaw, the mouth of the patient being tightly closed. Covered with iodine, the white silver line becomes very marked. For injections we use needles ten centimetres long and 0.8 millimetre thick. The needle is furnished with a bar, which could be replaced- by a cork. We measure from the point of the needle to the bar, a distance equal to that from the angle of the lower jaw (the mouth of the patient being closed) to the upper margin of the articular tubercle and we introduce the needle into the skin of the internal plane of the lower jaw angle. The point of the needle has to touch the bone. The needle will be then slowly advanced till the bar follows the direction of the skull base. To verify whether the needle really advances to the foramen ovale the following data shall be taken into consideration: the needle can be declined in sagittal or frontal direction. To avoid the sagittal deviation one has to remember that the articular tubercles and the oval orifices are upon one line; the prolonged direction of the needle must also coincide with the line uniting the puncture point with the upper margin of the articular tubercle, *i.e.*, with the "silver line."

The frontal deviation (inwards) must be avoided by considering the following figure: (Fig. 4)
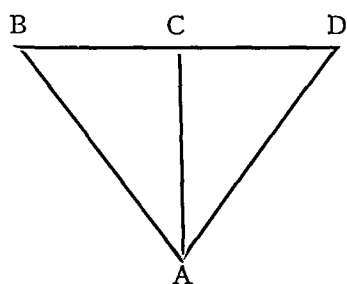
A—Angle of lower jaw.

B—Upper margin of the articular tubercle.

D—Oval orifice.

AC—Ascending ramus of the lower jaw.

FIG. 4.

The angle of the lower jaw (A) can, as mentioned, be regarded as the top of an isosceles triangle, the sides of which are formed by lines joining the mentioned angle with the articular tubercle (B) and the oval orifice (D). As AC (the sagittal plane of the ascending branch of the lower jaw), draws perpendicularly to BD, the angle CAD equals BAC, *i.e.*, the angle of deviation of the needle (AD) from the ascending branch of the lower jaw equals to the angle of deviation from the latter of the "silver line." That is to say, the frontal deviation (inwards) is of no significance; it amounts on an average a 22° angle.

When treating the question from the practical point of view, one has to keep in mind that at first the needle-point deviates a little to the median line till it does touch the planum intratemporale; by directing the needle-point a bit inwards one necessarily reaches the oval orifice.

The distance from the oval orifice to the upper border of the pyramid of the temporal bone, relying upon the examination of fifty-eight skulls by Härtel, varies from nineteen to twenty-three millimetres, the minimal dis-

tance being of fourteen millimetres. The distance from the oval orifice to the Gasserian ganglion is equal, on the average following our examination, to one centimetre. It is why the needle, after reaching the oval orifice, has to be advanced upward to a distance of one centimetre.

We suppose that the "gliding" of the needle through the oval orifice into the skull cavity after Härtel's method, mentioned by many authors, can be explained by the impossibility to definitely establish beforehand in any case the distance from the point of puncture to the oval orifice.

Running Nrs.	Distance from the angle of the lower jaw		Running Nrs.	Distance from the angle of the lower jaw	
	to the upper margin of the articular tubercle (Tubercul. Articulare)	to the oval orifice (Foramen Ovale)		to the upper margin of the articular tubercle (Tubercul. Articulare)	to the oval orifice (Foramen Ovale)
1	5.3	5.4	27	6.5	6.4
2	5.4	5.4	28	6.5	6.3
3	5.4	5.4	29	6.5	6.5
4	5.4	5.4	30	6.7	6.6
5	5.6	5.6	31	6.8	6.7
6	5.6	5.6	32	5.9	5.9
7	5.7	5.8	33	6.7	6.6
8	5.8	5.9	34	6.9	6.8
9	5.8	5.8	35	7.0	7.1
10	5.9	5.8	36	7.1	7.1
11	5.9	5.7	37	7.1	6.9
12	5.9	5.9	38	7.1	7.0
13	6.0	6.0	39	7.1	6.9
14	6.0	6.0	40	7.2	7.1
15	6.0	6.0	41	7.1	7.3
16	6.2	6.2	42	7.1	7.1
17	6.2	6.2	43	7.3	7.2
18	6.3	6.3	44	7.3	7.2
19	6.3	6.3	45	7.4	7.4
20	6.3	6.2	46	7.4	7.4
21	6.4	6.4	47	7.5	7.7
22	6.4	6.4	48	7.5	7.3
23	6.4	6.4	49	7.5	7.6
24	6.4	6.3	50	7.9	7.9
25	6.5	6.5	Averages	6.4	6.4
26	6.5	6.3			

From this point of view our method doubtless merits attention, as we can in every single case calculate the distance which is to be found.

By using our method we avoid the wounding of vessels; the external and internal carotid arteries and the jugular vein pass behind and outside. The internal upper jaw artery is bent upon the lower jaw and disposed sidewise from the passage of the needle making its way on the external surface of the external pterygoid muscle. At the perpendicular and horizontal sections the cavernous sinus has the shape of a triangle—the base upward and top downward. From the surgeon's point of view, the most interesting is the external partition, as on it pass (from top to bottom) N. trochlearis, the first branch of the N. trigeminus, N. oculomotorius, N. abducens. The internal carotid artery also perforates the external partition of the cavernous sinus.

Following the method of Härtel and of Harris, the needle can easily get into the cavernous sinus and wound the above mentioned nerves and vessels. Using our method we direct the needle upward and so avoid the sinus, which our examinations of cadavers demonstrated.

From the above considerations it may be concluded that with some practice the penetrating into the Gasserian ganglion, following our method, does not present much difficulty.

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CALCIUM CHANGES IN THE BRAIN IN ETHER ANÆSTHESIA

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In a recent communication it was reported by one of us that following ether anæsthesia profound changes occurred in the mineral salt balance of the blood. Concurrent chemical studies on the same individuals showed that the changes in the acid-alkali equilibrium, blood sugar, chlorides, blood-pressure, pulse, and a number of other factors were not of sufficient importance in the period of convalescence from anæsthesia to account for the patient's condition, but that a most striking feature was an exceedingly marked lowering of the Ca-K ration which in most cases fell below one during some portion of the twenty-four hours of anæsthesia. Marked changes in the permeability of the tissues as shown by the blister method of Gaennslen[2] (using a modification elaborated by Petersen[3]) were also discovered in these cases.

Blood Ca changes in anæsthesia had also been noted by other observers, especially by Emerson.[4] The importance of the Ca-K ration in such conditions is also brought out by Warner[5] whose studies on chorea showed a marked lowering of the ratio. Fischer[6] has made a very elaborate series on the Ca-K ratio in sleep and showed that it was a constant finding that the blood Ca was raised in sleep and the blood K lowered. This was true not only in normal sleep but in sleep brought on by hypnotics. These experiments were done on animals and he noted that these changes were abolished after decerebration. With these points in view, it was decided to study the matter from the standpoint of the Ca in the tissues themselves.

Protocols.—Nine dogs were used that were divided into groups of three each and each of them anæsthetized deeply with ether for forty-five minutes. One group was killed at the end of four hours, one at ten hours, and one at sixteen hours. During these periods frequent blood chemistry analyses were made. The carbon dioxide combining power was estimated by the method of Van Slyke and Cullen;[7] the phosphates by the method of Benedict and Theis;[8] the blood sugar by the method of Folin and Wu;[9] and the chlorides by that of Whitehorne.[10] The calcium was determined by the method of Kramer and Tisdall[11] and the potassium by the Kerr's modification of the Kramer-Tisdall[12] method. The pH determinations were made by the Myers and Muntwyler[13] method, except that the plasma separation tubes were not used. The killed animals were then autopsied and the calcium and chlorides determined in the brain and liver. Two other normal dogs were killed and the brain calcium determined as controls. In all cases here reported the tissue calcium determinations were run in duplicate and the figures checked within 10 per cent.

Methods.—The method of tissue analysis was as follows: For moisture determination ten grams of tissue are weighed out and dried to constant weight. For analysis

actually part of the cell membrane or cell protoplasm. Leiboff[14] reports the total absence of Ca from the red blood-cells and his work appears to be the most conclusive, since he used large volumes of material and his chemical methods seem reliable. Of course, red blood-cells make ideal material for study in this field because it is possible, at least theoretically, to free them from the surrounding material by washing, a process which is an obvious impossibility in any other tissue.

In these findings Leiboff is in agreement with Abderhalden,[15] Marriott,[16] and also with Rothwell.[17] However, there is some older work in which it has been reported that washed red-cells contain calcium, notably that of Cowie and Calhoun[18] and of Jones and Nye.[19] Other studies of electrolytes in the tissues have also given rather contradictory results.

Ranson[20] was unable to find any difference in the calcium content of normal muscles and muscles during parathyroid tetany confirming the work of Behrendt,[21] although Loughridge[22] found that the calcium was markedly lessened in the muscle tissues. Urano[23] found no calcium at all in the juices which he expressed from muscles of frogs legs. Quagliarello[24] has made a rather elaborate analysis of the electrolytes in both muscles and muscle juices and found electrolytes in all of them, calcium and potassium occurring in about two-thirds of the amount in them as in the solid muscle, but the sodium occurs in apparently equal amounts in the juice and in the muscle.

In this connection it is interesting to note the work on the mineral content of the skin. Elaborate studies by Nathan and Stern[25] of the skin in normal and pathological conditions led them to conclude that there was increased calcium under pathological conditions although there was a wide fluctuation in their normal findings. Previous to this the elaborate studies of Brown[26] on the mineral salts in the skin show rather clearly that an increase in Ca in the skin made it less irritable and that an increase in K made the skin more irritable. Also that the injection of Ca will reduce the irritability of the skin.

It can be seen from this brief review that, while the question is probably still an open one, most of the evidence appears to be that, for the tissues, excluding the human red cells, the well-known changes brought about by fluctuations in the mineral salt balance are due to actual changes in the cellular content of the electrolytes and not simply due to changes in the electrolytes in the surrounding medium.

Our own figures tend strongly to confirm this viewpoint, as can be seen by references to the chart. A change of 50 per cent. in the brain calcium has taken place. When one considers the amount of blood and serum which is included in any tissue Ca estimation, one would feel justified in assuming the changes in the electrolytes in the cells are of even greater degree. It would indicate probably at least 100 per cent. increase because at the very time when the brain Ca was at its highest, the blood Ca had returned to normal. There have been a few other publications on brain

Ca which tend to support this view. Quest[27] reports that the calcium in the brain is very high at birth and sinks rapidly as soon as the brain begins to function and that in children dying of tetany the brain Ca is much lower. Weigert[28] studied the brains of two puppies which died during tetany and found that the Ca was also much lower than in the controls. Cooke[29] reports diminution in the brain calcium of parathyroid-ectomized animals, and Macallum[30] has made detailed studies of Ca in the different parts of the brain during parathyroid tetany and finds that it is lowered about 40 per cent. in the cerebrum and slightly less in the lower brain.

All these figures of course are based on chemical studies such as ours in which the extraction of blood was impossible and therefore the actual changes in the cellular Ca were probably consistently higher than the figures would indicate.

It may also be noted on our chart that the inorganic phosphate of the blood rose markedly and then fell rather rapidly to its original value. This is interesting in view of the work of Boyd[31] showing that a hyperphosphatæmia causes an increased excretion of Ca and goes along with the experiments of Jaffee and Bodansky[32] on experimental osteitis fibrosa cystica who were also able to show the depletion of the body of Ca accompanied by a hyperphosphatæmia. Our experiments indicate, therefore, that a rise in phosphorus is accompanied by withdrawal of calcium from the blood not only into the excretory organs, as shown by the above authors, but into the tissues as well.

CONCLUSIONS

1. Ether anæsthesia in dogs is accompanied by a marked rise in the calcium in the brain as well as in the liver.

2. These changes are probably to be interpreted as meaning a lesser activity and irritability of the brain cells due to changes in the mineral salt content in the cells themselves.

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VALUE OF CORDOTOMY FOR THE RELIEF OF PAIN*

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Cordotomy for relief of pain has been practised in this clinic since 1916. During the past fourteen years, fifty-one cordotomies have been performed upon forty-eight patients. Sufficient material, therefore, is at hand from this and other clinics to reach definite conclusions as to the value of this operation in the relief of pain.

The type of case in which section of the pain-conducting pathways in the cord seems indicated can be well illustrated by outlining an early experience with this procedure.

L. W. G., male, aged forty-four, entered the University Hospital in January, 1917. The chief complaint was pain in the rectum, buttocks and thighs. Eighteen months previously rectal examination had revealed a large cancerous growth just above the anal canal filling the lumen of the bowel. Since the growth appeared inoperable, a colostomy had been made and intensive radium therapy instituted. The colostomy functioned well. Pain in the regions described developed and was intense, continuous and demoralizing. Large doses of morphine gave only partial relief. Inasmuch as the tumor was slow-growing with severe pain as its chief symptom, cordotomy seemed indicated. Laminectomy of ninth and tenth thoracic vertebræ was performed and bilateral section of the antero-lateral tracts made at the level of the twelfth thoracic and first lumbar segments.

January 25, 1917, one week after operation, there was a flaccid paralysis of the left lower extremity and both the patella tendon and Achilles tendon reflexes were diminished. There was no motor disturbance of the right lower extremity and the reflexes were normal. Patient complained of bearing-down pain in bladder.

Physical Examination (February 2, 1917).—*Right Lower Extremity. Sensation.*—Preservation of tactile sensation throughout. Loss of thermal and pain sensation over the buttock, perinæum, posterior aspect of the thigh and below the level of the knee. No disturbance of sense of position. *Motion.*—Movements of the limb are unimpaired. *Reflexes.*—Patella and Achilles tendon and cremasteric reflexes normal. Abortive ankle clonus. Dorsal flexion of great toe.

Left Lower Extremity. Sensation.—Patient can distinguish between hot and cold and the prick of a pin throughout extremity. The sense of touch is preserved although patient states sensation is not so acute in the anterior and lateral surfaces of the thigh. There is no disturbance in the sense of position. *Motion.*—All movements of the left lower extremity, temporarily arrested after the operation, have been restored. *Reflexes.*—Achilles and patella tendon reflexes more active than at last examination, January 25th. Ankle clonus and Babinski present. The patient still has attacks of vesical tenesmus but they are not so frequent nor so painful as formerly.

The patient was discharged April 21, 1917. There had been no change in the sensory disturbances as noted February 2, 1917. Several attempts were made to have the patient return for continued radium treatments, but without success. During the war he was lost sight of.

September 10, 1919, the patient wrote: "I do not feel any soreness in the perinæum

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* Read before the Philadelphia Academy of Surgery October 6, 1930.

or rectum. I ride a bicycle a great deal without discomfort. My appetite and digestion are good and my limbs are strong."

On May 23, 1920, just four years after the patient came under observation, his condition was reported through a verbal communication as very satisfactory.

In June, 1922, the patient was reported to have died from unknown cause, three months ago. There had been no recurrence of pain.

[This is Case III previously reported by Frazier in Arch. Neurol. Psych., 1920, vol. iv., p. 137.]

Comment.—This is an excellent example of the value of cordotomy. It was not the malignant tumor of itself but the pain it produced by pressure on sensory nerves that would have shortly destroyed the patient. Once this pain was relieved by cordotomy he lived comfortably for five years.

If in the course of a disease sensory nerves are affected, pain at once becomes a most distressing feature. And there is no more intense, continuous, or intractable pain than that arising from involvement of the posterior roots of the spinal cord by neoplasms or inflammation within or without the vertebral canal. Furthermore, if in addition to the pain the sufferer is aware that its cause may be a malignant, incurable disease, the mental as well as the physical anguish to be endured is easily appreciated. In the past, for the most part, recourse to morphine has been necessary to render life bearable, at best an unsatisfactory intermittent relief, requiring increasingly large amounts of the drug to dull the pain. However, the value of sectioning sensory pathways leading from the site of the pain has long been appreciated though but infrequently employed. Dana in 1886 first proposed section of the posterior roots of the spinal cord to afford relief, and Bennett[1] and Abbé[2] reported the first successful results from this procedure. Although Chipault,[3] Ballance,[4] Groves,[5] Hildebrand,[6] Jacoby,[7] Jones,[8] Foerster,[9] and others gave posterior rhizotomy a thorough trial, the operation gradually fell into disrepute. It was abandoned because there is such a marked overlapping of sensory nerve distribution to the same skin area that to produce complete anæsthesia at least three roots must be cut. Hence, two roots above and below the region involved had to be sectioned. Consequently, if the pain was widespread a very extensive laminectomy and rhizotomy was necessary, an operative procedure of such magnitude that it involved great risk to an already debilitated patient. Furthermore, when the posterior roots have been severed sensory loss in the parts involved is complete, motion and position discrimination as well as pain and temperature being abolished, which interferes markedly with proper motor control. It was obvious that until the pain fibres alone could be picked out, relief of pain by section of sensory pathways was accompanied by too many handicaps to be considered entirely practical.

Although in 1879, Gowers[10] suggested that pain and temperature fibres probably passed upward within the cord in the tract that bears his name, a fact which Van Gehuchten[11] asserted positively in 1893, it was not until 1904 that the brilliant clinical observations of Spiller[12] proved that these sensations were carried upward in the antero-lateral tract. In 1910 Schuller[13] on purely

theoretical grounds advised that sensory pathways in the cord might be cut to relieve the pain arising from gastric crises. Petren,[14] Rothman,[15] and Fabritius[16] on clinical and experimental grounds confirmed Spiller's findings. But in 1912 Spiller and Martin[17] reported a case operated upon January 19, 1911, in which bilateral cordotomy or section of the antero-lateral pathways in the cord was performed for relief of pain due to a malignant inoperable tumor on the left side and lower part of the spinal cord. As Spiller anticipated, the pain was relieved, although touch and position sense seemed unimpaired. Upon examining the patient a year later, he felt that the operation had been successful. It is to Spiller, therefore, that the credit for originating this valuable and merciful suggestion must be given. At this same time Cadwalader and Sweet[18] at Spiller's suggestion performed experimental work on dogs which gave further evidence that pain fibres were carried through these antero-lateral pathways. Although Beer,[19] Souttar[20] and Tietze[21] at Foerster's suggestion performed cordotomy for relief of pain with success, pain being relieved without impairment of motion or sense of touch or position, the operation did not receive the attention it merited until the report of Frazier[22] appeared. Spurred on by Spiller, six cases, having intractable pain in the lower extremities, due to malignant tumors or gunshot wounds involving the lower spinal cord or the posterior roots, had cordotomies performed with complete or marked relief of pain. Three years later in further collaboration with Spiller[23] seven additional cordotomies were described by Frazier. In these cases pain sensation was destroyed without motor impairment or complete loss of other sensations which had proved to be the great disadvantage of posterior rhizotomy. Based on his experience Frazier perfected a method which made easy a section of only the antero-lateral tracts, and avoided damage to the motor fibres. As a result of Frazier's description of the technic of cordotomy and a confirmatory report of Leighton,[24] who relieved three cases of gastric crises and one of severe pain in the legs following spinal trauma by this procedure, the value of section of the antero-lateral columns for relief of pain was firmly established.

Since the appearance of Frazier's and Spiller's report, Sicard and Robineau,[25] Peet,[26] Banzet,[27] Foerster,[28] Horrax,[29] Stookey,[30] Stebbing,[31] Beck,[32] Towne[33] and Bankart[34] have all recorded series of cases successfully relieved of pain by this procedure. Sufficient time has elapsed, therefore, and enough clinical material is available in the literature and from the 48 cases from this clinic to arrive at a just conception of the value of this procedure.

Cordotomy has three distinct advantages over the other methods of relieving pain. Firstly, a greater area of anæsthesia can be produced by section of the antero-lateral pathways than by any other means; secondly, pain and temperature sensations alone are obliterated without involvement of touch or position sense and hence motor function remains unimpaired; lastly, the operative procedure requires only a small laminectomy and is, therefore, much less exhausting to debilitated patients. But cordotomy has the disadvantage that unless the incision into the cord is accurately placed, the pain may not be

completely relieved or the motor pathways may be damaged, resulting in paralysis of the legs and interference with sphincteric control.

A very distinct advance in the technic of cordotomy has recently been made following the discovery that section of the pain fibres in the cord causes the patient no distress. Manipulation of the posterior roots is painful, but curiously enough cutting into the antero-lateral tracts is not. Hence the operation may be carried out under local anæsthesia, or preferably nitrous oxide analgesia plus local anæsthesia, which holds the patient quiet until the adjacent posterior roots have been separated and the cord rotated ready for cordotomy. The anæsthesia is then stopped so that tests of level of sensory loss following incision into the cord may be made on the conscious patient. The reports of Foerster[9] and Wilson and Fay[20] have shown that the section in the cord may be gradually deepened until just sufficient pain fibres are cut to produce anæsthesia to the level required and no higher. Since the fibres that supply the lower extremities lie most superficial in the antero-lateral columns, by this means carrying the incision to an unnecessary depth into the cord and hence possible injury to the pyramidal tracts may be avoided. Futhermore, Spiller suggested to Wilson and Fay that by immediate testing in this way it might be possible so to place the incision that the pain fibres alone were cut and temperature tracts avoided. Stookey reported four cases in which following a relatively shallow cordotomy temperature sense was retained although anæsthesia to pain was produced. Recent cases from this clinic have confirmed these findings. Such observations are extremely important from the neurophysiologic standpoint as they offer definite proof that pain and temperature fibres run in separate and distinct fibre tracts in the cord. The reports quoted and our own experience seem to suggest that the temperature fibres are located more centrally, while the pain fibres lie superficially over a larger surface area. If the incision is carried from exactly the plane of attachment of the dentate ligament forward to just beyond the level of the emergence of the anterior root, it need not penetrate to a greater depth than 2½ millimetres at any point. If the pain is referred to an area lying below the iliac crest, immediate tests may show a level of anæsthesia above this region before a depth of 2 millimetres has been reached. When the importance of avoiding too deep a section which may involve the pyramidal tracts and result in paralysis is considered, this suggestion of Spiller's is a distinct advance in the technic of corodotomy.

Cordotomy may be performed either unilaterally or bilaterally depending on the extent of the pain. If the pain is referred to the bladder or rectum, or if it is caused by a rapidly spreading malignant tumor, the wiser course is to do a bilateral section. When both antero-lateral columns are to be cut, the incisions should not be made at the same level, but must be separated by at least one whole segment. In this way interference with the blood supply to the cord, possibly producing a transverse lesion, is avoided. The cord may be sectioned as high as the sixth cervical segment if necessary. Incision at a higher level may involve the phrenic distribution, causing respiratory embar-

rassment. The third or fourth thoracic segment is the point of election for cordotomy. In this region the vertebral curve brings the cord into a relatively superficial position, the cord is small and may be rotated easily, all possibility of diaphragmatic involvement is avoided, and anæsthesia as high as the ensiform cartilage may be produced. The operative incision is made in the mid-line from the first to the fifth thoracic spines and the second, third and fourth spines and laminæ removed. It is important that the laminæ be rongeured away as widely as possible, for the greater the lateral exposure the more readily may the cord be rotated for section. After hæmostasis has been completed, the dura is carefully opened and retracted to either side with stay sutures. If possible the arachnoid should be included in the sutures and reflected with the dura. Care must be taken, however, in reflecting the arachnoid lest a fine blood-vessel or two which pass from it to the cord may be torn. Even the slightest hæmorrhage impairs the chances of a successful result. Next a dentate ligament as near the centre of the incision as possible is identified and the anterior and posterior roots running adjacent to it separated from the cord. Extreme delicacy should be used in handling the roots, first because minute arteries accompany them, and second, because manipulation of the posterior root is painful and may cause the patient to strain. The dentate is seized in a mosquito hæmostat and cut at its dural attachment. Gentle traction on this ligament will rotate the cord posteriorly until the point of emergence of the adjacent anterior root and the anterior fissure of the cord may be seen. The incision into the cord is the next step. Posteriorly the section should begin exactly at the point of emergence of the dentate ligament, extend anteriorly to just beyond the level of emergence of the anterior root and reach a depth of 2½ millimetres at its mid-point. It is difficult to place the incision exactly for the pia over the cord seems at times very tough and resistant, and the dentate ligament may be torn off during the attempt to cut the lateral columns, leaving no way of steadying the cord. For this reason the cordotomy hooks devised by Frazier are important. By their use the cord may be steadied so that a much more accurate section is possible. It has been stated by a number of observers (Horrax and Peet) that the cordotomy hooks fail to permit of a sufficiently deep section to produce complete relief of pain. Therefore, they advise the use of a straight cataract knife for making the incision. The first cordotomies in this clinic were performed in this way. The very obvious difficulty of controlling the cord with the dentate ligament alone forced the development of the hooks. Since this method of steadying the cord was adopted, in but three cases in thirty-nine in which the hooks were used, not only to steady the cord but to limit the depth of the section, has the incision failed to cut sufficient fibres to relieve the pain. In four cases in this clinic done under local or nitrous oxide anæsthesia, so that the level of sensory loss could be determined as the section was made, the cordotomy hook was introduced in a very superficial manner just under the pia at a point immediately anterior to the insertion of the dentate ligament. The hook steadied the cord perfectly as with a straight

knife the usual section was made and deepened until the sensory tests coincidentally carried out showed that the level of anæsthesia had reached the required height. The results in these cases were extremely satisfactory.

If the loss of sensation is to be determined during the operation it is important that the patient be fully acquainted in advance with the type of tests to be employed. Accurate responses will not be obtained from a patient
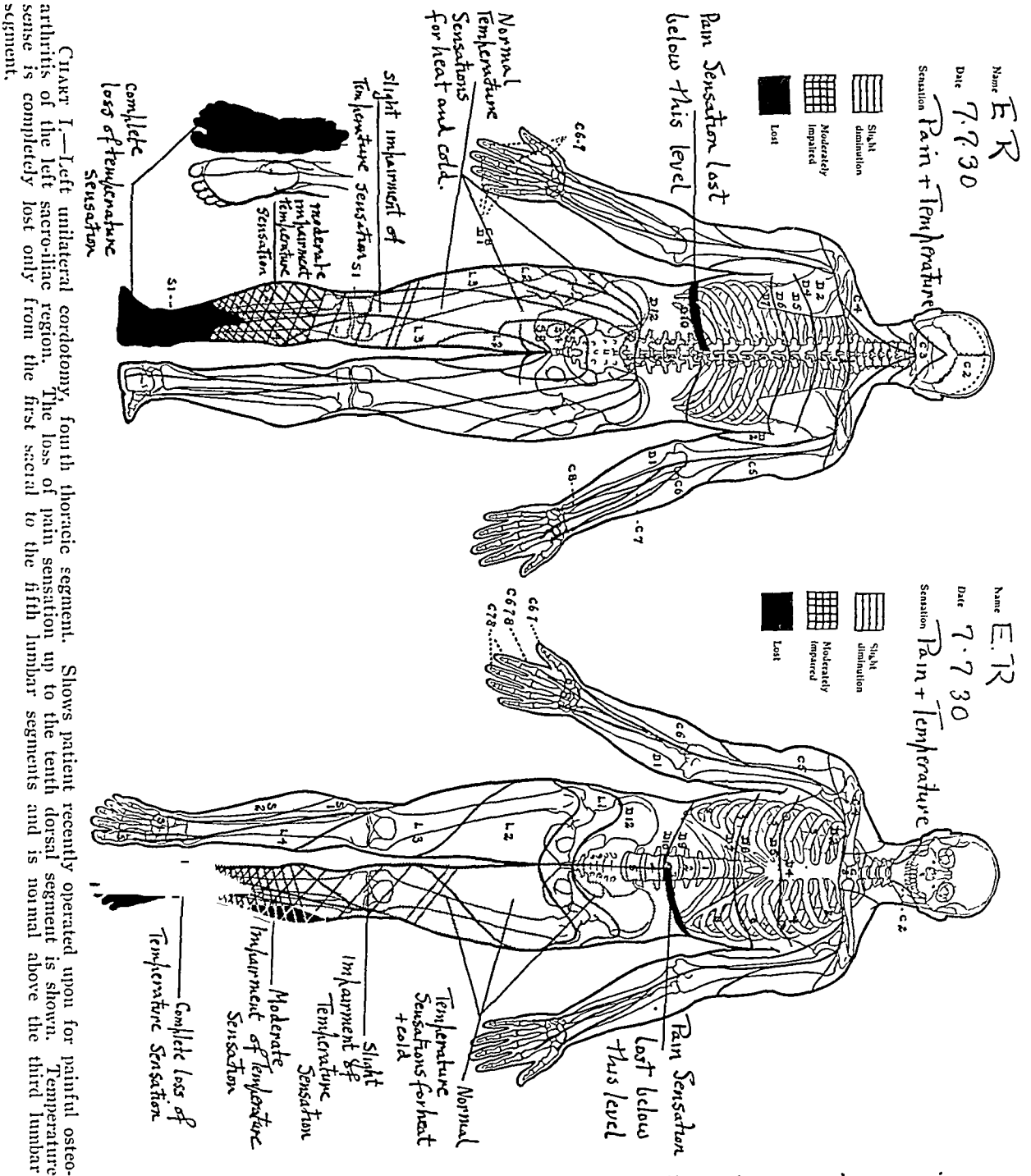
operated upon under gas-oxygen anæsthesia and allowed to regain consciousness during the actual incision into the cord, for the mental confusion will be too great unless the methods of determining the level of anæsthesia have been carefully rehearsed beforehand. While we have tried local anæsthesia alone in these cases, it is our opinion that it is too painful a procedure, especially when the posterior roots are handled, to be recommended.

The results of the fifty-one cordotomies on forty-eight patients in this series are given in detail in Tables I, II, III and IV. The anæsthesia produced by proper section of the antero-lateral columns at the level of the third or fourth thoracic segments has been so repeatedly illustrated by reports from this and other clinics that further comment here is unnecessary.

The real test of the value of cordotomy is the degree of relief from pain it affords. In experienced hands there is no doubt but that immediate complete relief of pain may be confidently assured. Complete relief of pain is rigidly defined in this series. The patient must be actually pain-free without

TABLE I
Cordotomy

48 cases   51 cordotomies
31 males   17 females
                    Average age 47 years

Bilateral cordotomy 29
Unilateral cordotomy 22
Completely relieved 39
75 per cent. relieved 8
50 per cent. relieved 2
Not relieved 2

recourse to morphine or other type of sedative to be so classified. In the four cases described as only 50 per cent. relieved or not relieved at all, unilateral cordotomies were performed when both columns should have been sectioned and pain appeared promptly on the opposite side. Very careful questioning as to the site and distribution of the pain is essential. Often these patients have a major pain in one region of which they complain with great bitterness, failing to mention a moderate amount of distress referred to the opposite side. When the antero-lateral columns contralateral to the side of the major pain are sectioned with consequent relief, the hitherto minor distress on the opposite

TABLE II
Cordotomy
Cause of pain

Malignancy of G-U tract or genitalia 18
Malignancy vertebræ 8
Gunshot wound spine 4
Sarcoma hip 4
Retroperitoneal sarcoma 2
Painful stump 2
Tabetic crises 2
Other causes 8

side remains and is magnified until the situation is well-nigh as bad as it was before operation. Occasionally the pain lies high up about the umbilicus or even as high as the ensiform. This is frequently the distribution in gastric crises. Under such circumstances cordotomy at the fourth thoracic segment will have to be very carefully placed and all the fibres sectioned to bring the level of anæsthesia above this region. Although sensory examinations following cordotomy seem to show (Foerster) that pain fibres decussate in the cord within one segment of the level of their point of entrance, and hence cordotomy at the fourth thoracic segment should produce skin anæsthesia as high as the fifth dermatomere, if it is necessary to produce loss of pain right

up to the level of the cord section it is wise to tie and cut the posterior roots that lie in the operative field. The second, third, fourth, fifth and at times the sixth thoracic roots may be seen in the usual cordotomy incision. If the pain to be relieved is situated above the umbilicus, cordotomy should be supplemented by rhizotomy of the ipsilateral posterior roots thus exposed. Patients with gastric crises should have rhizotomy as well as cordotomy, for in tabetic cords the adhesions make accurate section of the pain fibres difficult, and, furthermore, the pain is often referred well up under the sternum.

Where a chronic stationary condition such as osteo-arthritis, a painful

TABLE III
Bilateral Cordotomy
Twenty-nine Cases
Complications

Vomiting 3
Distension 4
Retention urine 8
Motor weakness 6
Died 3
    Meningitis 1
    Shock 1
    Cachexia 1

stump, a gunshot wound or other injury to the pelvis involving the lumbo-sacral nerves, or tabetic crises, is the cause of severe incapacitating pain, the indication for its relief by cordotomy is unquestioned. Such patients may have a normal life expectancy and cannot continue indefinitely to dull the pain with morphine. Fourteen such cases are included in this series. One died following cordotomy. Five of the remainder are known to be alive and pain-free. Six could not be traced and three are dead after an average life period of five years, during which they had no further complaints.

TABLE IV
Unilateral Cordotomy
Twenty-two Cases
Complications

Vomiting 1
Distension 1
Retention 2
Motor weakness 1
Died 4
    Cachexia 2
    Pneumonia 2

But where a malignant tumor, especially a rapidly spreading growth, produces pain, then the point can be raised that the sufferer may be made comfortable by morphine for the last few months of life without subjecting him to the added distress of an operation. Frankly, we think that such an argument smacks of sheer cruelty. Cordotomy in experienced hands is so certain to give relief, the period of acute post-operative discomfort is never over five days, that we feel it is an entirely justifiable procedure provided that the patient is not a hopeless operative risk. However, cord section is never insisted upon, the sufferer only being told that he can be made entirely comfortable if he is willing to have the procedure carried out. Most of these

unfortunates gladly accept any chance of relief for they know how intermittent and unsatisfactory are the results of sedative drugs. Of the twenty-six patients having pain caused by malignant disease, one lived five years (Case I), and the post-operative life period of the other twenty-five averaged just over nine months following cordotomy.

It seems obvious that this suggestion of Spiller's for relieving intractable pain by section of the antero-lateral columns of the spinal cord is a practical, justifiable and merciful procedure. When its possibilities are more widely appreciated and when patients are brought to the surgeon before they are so debilitated by cancer or weakened by constant suffering that they are bad surgical risks, the mortality will be reduced. It behooves the medical profession at large to realize that pain can be relieved easily by cordotomy with relatively little risk, to recommend it earlier, and thus to prevent pain from becoming the harassing factor it has all too often been allowed to develop into in the past.

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POST-OPERATIVE PAROTIDITIS: TREATMENT WITHOUT AND WITH RADIUM *

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Among the most unexpected and dangerous complications which occasionally follow surgical procedures—especially those that involve the gastro-intestinal tract—is an acute, inflammatory, and frequently suppurative process of the parotid gland, unilateral or bilateral. The reason for infection of the parotid gland following operation is not clear, as a glance at the literature, which offers such a multitude of etiologic explanations, shows. High mortality has accompanied this group of cases, particularly when the process has gone on to suppuration, requiring incision. Regardless of treatment, the prognosis is guarded and frequently grave.

Since we have observed the beneficial qualities of radium packs in the early stages of this sequela, it occurred to us to review all of the cases which have occurred at The Mayo Clinic in the last four years, with comparison of the various therapeutic agents employed. The seventy-eight cases which we were able to find, in twenty of which radium was used, showed some very interesting as well as informative facts.

INCIDENCE.—The incidence of this complication after general surgical procedure, including surgical procedures of the upper part of the gastro-intestinal tract and small bowel, is relatively low. Pique, in 1907, in a series of 7200 general surgical operations, encountered two cases of post-operative parotiditis. Likewise, Beckman, in 1903, reporting on complications observed in a series of 6825 surgical operations performed at The Mayo Clinic, encountered only three cases of post-operative parotiditis. The ratio of incidence of this complication was 1 to 3600 in Pique's series, and 1 to 2275 in Beckman's series.

One is immediately impressed, however, with the greatly increased incidence of post-operative parotiditis with the development of surgery of the colon. There must be, it seems, some local cause, incidental to surgical attack on the colon, to some technical procedure in extirpation of the colon, or to the post-operative treatment, which greatly increases the occurrence of parotiditis. Twenty of our seventy-eight cases followed major surgical operations on the colon or the rectum. In the course of the period in which 2,700 operations were performed on the colon and rectum, these twenty cases of post-operative parotiditis occurred. This gives an incidence of one case in

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135 operations on the colon or rectum, nearly seventeen times as many as the number encountered in general surgery at The Mayo Clinic.

ETIOLOGY.—A review of the discussions of various authors on the etiology of post-operative parotiditis suggests five different theories: (1) according to the pyemic theory, secondary parotiditis is a pyemic phenomenon due to embolism of the parotid vessels, with a septic clot derived from the primary focus of infection; (2) by the heat degeneration theory, secondary parotiditis is recognized as a parenchymatous degeneration of the gland due to hyperpyrexia; (3) in the toxin excretion theory, secondary parotiditis is attributed to infection of the gland following an unsuccessful attempt to excrete toxin manufactured by the organisms of the primary disease; (4) in accordance with the sympathetic theory, parotiditis is produced sympathetically, secondary to operations on the generative organs; and (5) according to the duct infection theory, secondary parotiditis is produced by direct extension of microörganisms along Stenson's duct from the mouth.

Two of these theories, the duct infection theory and the pyemic theory, have gained considerable support in the literature. Among these advocating the duct infection theory may be mentioned Claisse and Dupré (1894), Girode (1894), Hanau and Pilliet (1889), Rolleston and Oliver (1909), Fenwick (1909), and Blair and Padgett (1923). Among those supporting the pyemic theory are Padget (1886), Bowe (1905), Dyball (1904), and Fisher (1919).

Claisse and Dupré (1894), experimenting with dogs, tried in various ways to produce secondary parotiditis. They found that in normal animals they could not produce the condition by smearing the orifice of Stenson's duct with microörganisms, by injecting virulent organisms into the duct, or by creating an artificial fistula. However, in an animal, the general vitality of which had been depressed, either by starvation or by injection of drugs such as opium which would limit the flow of saliva, infection of the parotid gland could be produced by any of these means.

Bucknell (1905) was one of the first to recognize the importance of the experimental work of Claisse and Dupré. Bucknell wrote: "It is evident, therefore, that for allowing infection to occur in the case of the parotid duct, as has been more or less proved in the cases of the kidney and bile passages, one or the other following abnormal conditions must be present: (1) microörganisms must be present at the orifice of the parotid duct, in larger numbers or of a more virulent type than usual; (2) the general vitality of the subject must be reduced so as to render him more liable to succumb to microbic infection; (3) the quantity of secretion passing down the duct and protecting it must be diminished; and (4) the quantity, and, more particularly, the bactericidal proportion of the saliva secreted must be lowered."

Turning to the question of secondary parotiditis in man, and referring to the disorders which have been complicated by this disease, it is evident that they all present one common feature; that is, they are all likely to be accompanied by those conditions which Claisse and Dupré have shown to be successively present, before infection of the duct can be produced in animals.

In a review of our seventy-eight cases, facts were not discovered which would substantiate a single type of cause in all. In the group of cases in

which operation was done on the colon, particularly, we were confronted with many conditions which certainly are disadvantageous to any surgical procedure any which may influence complications. Such conditions are age, debility, dehydration, arteriosclerosis, and infection of long standing. Interference with mobility of the colon, and production of obstruction, with its concomitant sequence of steady absorption and devitalization, unquestionably must influence production of the complication of parotiditis. Likewise, it is not at all certain that starvation after operation, which is imposed on patients who have undergone resection of the colon and rectum, may not have an important bearing. Usually, patients subjected to major abdominal procedures are refused fluid by mouth for only twenty-four to forty-eight hours, unless there is some exceptionally valid reason for such deprivation. It has been our routine procedure to keep patients who have had resection of the colon and rectum without food or drink by mouth for three to four days. The content of water of the body is maintained by intravenous injection and hypodermoclysis. At the same time, conservation of function of the parotid gland is attempted by permitting the patient to suck lemons or chew gum. Nevertheless, in spite of all of these precautions, parotiditis occurred nearly seventeen times more often among patients who underwent resection of the colon and rectum than, for example, among patients who underwent gastric operations.

VARIOUS FORMS OF TREATMENT

All authors are in agreement that as soon as suppuration can be definitely recognized, the gland should be incised, but there is disagreement as to just when suppuration is present. The only sign which is pathognomonic of suppuration in the parotid gland is fluctuation; when this appears the gland should be lanced. It is unwise to lance a gland in the hope of penetrating to a region of deep suppuration because one may be disappointed in finding it, and injury to the facial nerve is almost certain to result. We have frequently seen glands rupture and discharge from the ear before suppuration could be demonstrated by the sign of fluctuation, and then, after the gland has been lanced, we have seen a satisfactory outcome. Unnecessary drainage of the gland, and, perhaps, spread of the infection, is frequently avoided by waiting for a definite sign. In many cases, under the influence of hot fomentations or ice, as the choice of the surgeon indicates, suppuration never appears. Our experience with radium also has been that it tends to prevent suppuration. Not only may one mistake infection for suppuration about the third or fourth day after operation, but frequently, if one is not in a hurry to incise the gland, drainage from Stenson's duct may take place to relieve the condition.

Blair and Padgett, in 1923, reported twenty-five cases of secondary parotiditis, thirteen of which occurred post-operatively. Of these thirteen cases, surgical drainage was instituted in nine; seven of the patients died, giving a mortality rate in the thirteen cases of approximately 54 per cent. Paget, in 1886, reported seventy-seven cases of secondary parotiditis, twenty-eight of

which occurred post-operatively. In these twenty-eight cases, surgical drainage was applied in fourteen, and thirteen patients died, a mortality rate of approximately 46 per cent. for the series. Fisher, in 1923, reported six cases of post-operative parotiditis with two deaths; in four of the cases the glands were drained surgically. In the fifty-eight cases from the records of The Mayo Clinic in which treatment by radium was not given and in which accurate records could be found, twenty-three of the patients died. Surgical drainage was applied in the twenty-four cases in which suppuration occurred, and fourteen of these twenty-four patients died, giving a mortality rate of 50 per cent.

In many cases in which parotiditis follows some operative procedure, death is due to the primary lesion, or, possibly, to some other complication. In commenting on this point, one of the earliest observers, Paget, in 1887, in a study of 101 cases, of which twenty-eight occurred post-operatively, wrote: "But out of these thirty-seven who died, three were over eighty years of age, three had internal cancers, one had perforation of the bowel, two had strangulated hernia, seven had undergone very severe operations, involving abdominal section, and thirteen died of septicemia or pyemia. If we add to these deaths one from infantile syphilis, one from marasmus, one from heart disease, we shall see that these thirty-seven patients did not die from parotitis, but from the primary lesion or some form of blood-poisoning after it. Thus, it is not possible to say how far this form of parotitis is in itself dangerous; the danger lies not in it but in the primary lesion." Of the more recent observations, those of Blair and Padgett may be cited. In the fourteen cases of post-operative parotiditis reported by them, seven patients died. However, in only three of these cases could the parotiditis be considered the primary cause of death.

In order to get a fair conception of the mortality rate in regard to this complication following operation, we reviewed, as a group, seventy-nine cases of post-operative parotiditis reported in the literature. In these seventy-nine cases, there were thirty-six deaths, by far the majority of which followed abdominal operations.

In the tabulation are listed forty-nine of the cases from The Mayo Clinic, in which parotiditis followed major surgical procedures and in which radium was not used. It is easily seen from this tabulation that the more serious the operation, the more unhappy is the prognosis when post-operative parotiditis develops. For instance, there were three cases of unilateral, suppurative parotiditis following resection of the colon, with two deaths, whereas there were two cases of bilateral, suppurative parotiditis following pelvic operations, with no deaths.

The question as to whether the infection is unilateral, or invades both parotid glands, necessarily has some bearing on the mortality, since the massiveness of the infection and the multiple foci invariably influence prognosis. There were sixteen cases of bilateral parotiditis, with nine deaths, a mortality rate of 56 per cent., whereas in thirty-three cases of unilateral parotiditis, there were only twelve deaths, a mortality rate of approximately

36 per cent. By referring to the tabulation, it is readily seen that of the twenty-two cases in which suppuration was present, the mortality was excessively high; thirteen patients, or approximately 60 per cent., died. In the seventy-eight cases from The Mayo Clinic, which have been reviewed, fifty-eight of the patients were not treated with radium, and of these twenty-three died, a mortality rate of approximately 39 per cent., which compares favorably with the mortality rates reported by other observers.

By using radium, and particularly by its immediate application within one or two hours following beginning of the swelling in the region of the parotid gland, we have been able, by reduction of the incidence of suppuration and absorption, to decrease noticeably the morbidity and the mortality. To be most advantageously employed, radium must be applied as soon as the first symptom of parotiditis appears. In our cases, as soon as we began to observe the satisfactory results from the use of radium, we attempted to apply it at the very earliest possible moment; regardless of the time of day or night that a swelling of the parotid gland appeared post-operatively, radium packs were used. The technic of treatment varies somewhat with the severity of the disease, but, ordinarily, a large dose is not necessarily more effectual than a dose of medium size. The maximal dose administered was four applications, eight hours in duration, at intervals of eight hours, of four 50-milligram tubes of radium. Filtration was through two millimetres of lead, one millimetre of brass, and 0.5 millimetre of silver; the distance was 2.5 centimetres and the total milligram-hours 6605. The minimal dose used was two applications, eight hours in duration, at intervals of eight hours, of two fifty-milligram tubes of radium. Filtration was through the same materials as those used in the maximal dose. The total dosage was 800 milligram-hours.

For the first twenty-four to forty-eight hours, there is no appreciable change in the symptoms. The swelling may be extreme, and the temperature 102° to 103° F.; the toxemia may be severe, and the patient may even become somewhat irrational. However, after the first twenty-four to forty-eight hours, in the average case, there is usually rapid improvement. The swelling remains more symmetrical, and definite lobulation does not appear in the gland. There is no tendency toward suppuration. The temperature approaches normal, and the toxemia rapidly disappears. Usually, in the less severe cases, only a small swelling remains after the fifth day, and the patient is able to take nourishment and feels well.

Of the twenty cases treated with radium, in only two was it necessary to substitute surgical drainage. This, we believe, is the most important point in favor of the use of radium. As has been stated, Blair and Padgett instituted surgical drainage in about 70 per cent. of their cases of post-operative parotiditis, and Paget in 50 per cent. In our cases, before the use of radium, we employed surgical drainage in 50 per cent.

In the fifty-eight cases in which radium was not used (see table), as has been said, twenty-three of the patients died, a mortality rate of approximately 39 per cent. Of the twenty patients treated with radium, only four died. Two of these deaths occurred two weeks and one month after the parotiditis

had completely subsided and can be definitely excluded; death in these two cases was due to pyelonephritis and uræmia, respectively. In another case at necropsy the primary cause of death was found to be a retrosigmoidal abscess, and in the fourth case no cause was found to explain the death except general weakness and the parotiditis. This gives a mortality rate in *the cases treated with radium of only 5 per cent. if three cases can be excluded.*

These good results naturally incited us to some attempt to explain the mechanism of the action of radium. Desjardins, who, in 1930, reviewed the literature on the beneficial effects of radium and Röntgen-ray in inflammatory conditions such as furuncle, carbuncle, pneumonia, trachoma and erysipelas, concurs in the opinion that the direct action of the rays on the infiltrating leucocytes, rather than the direct action of the rays on the infecting organism, probably is responsible for the satisfactory results.

Desjardins stated that Heineke was the first to establish the exceptional sensitiveness of lymphocytes to Röntgen-rays and radium. He exposed animals to large doses of radiant energy and found that they invariably died.

Forty-nine Cases of Post-operative Parotiditis Treated without Radium

Operations	Unilateral				Bilateral			
	Simple		Abscessed		Simple		Abscessed	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
On pelvis...........	5		3		1		2	
Colostomy..........	2		1	1	1	1		
Resection of colon....	4	1	3	2	1	1	2	1
On stomach.........	1	1	2	2			1	1
On gall-bladder......	3	1	3	2				
Enterostomy........	1						3	2
On kidney..........	1							
Multiple operations ..	1				2	1		
On bladder.........	1	1					2	2
On ruptured appendix	2	1			1			

He observed, at necropsy, that although the majority of the organs appeared normal, the spleen, lymph-nodes and lymph follicles throughout the body gave evidence of marked destruction of lymphocytes. This disintegration of the lymphocytes was found to take place within two hours after the animals had been exposed to irradiation. Desjardins stated that the observations of Heineke have been fully confirmed by numerous experimenters. Warthin found that the lymphocytes showed signs of disintegration even within fifteen minutes after exposure of the animals to the rays.

From the time of Cohnheim, it has been thought that lymphocytic infiltration is one of the most important steps in the natural defense of the organism against infectious processes. How, then, may the apparent benefit of radium in infectious processes be explained on the basis of the destruction of the leucocyte? Commenting on this point, Desjardins stated that he has never seen any harm come from the irradiation of these inflammatory

processes. He further expressed the belief that through disintegration of the lymphocyte, valuable protective antibodies are liberated which tend to neutralize toxic products of the infective organisms.

A review of our own cases, then, and a comparison of the end-results following the use of radium and other therapeutic agents in the treatment of post-operative parotiditis leads us to the conclusion that the application of radium greatly reduces the incidence of suppuration and thus influences markedly the mortality rate.

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POST-OPERATIVE CORONARY OCCLUSION

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In 1910 Osler[1] correlated the clinical and pathological findings in occlusion of the coronary arteries. Two years later Herrick[2] described the clinical syndrome clearly and really stimulated modern interest in the subject. Coronary thrombosis as a post-operative complication has apparently received very little consideration. Wilson[3] mentions one case of coronary embolism in a review of forty-seven cases of post-operative embolism. This followed a gastroenterostomy for chronic duodenal ulcer. Neuhof and Aufses[4] have recently studied the cause of death after operation in eight hundred consecutive autopsies in three New York Hospitals. In this series there is no reference to coronary occlusion. Balfour[5] reviewed fifty-one deaths following operations on the stomach and duodenum, one of which he has listed as due to coronary thrombosis. Herrick[6] mentions one death following cholecystectomy. Apparently the condition has not interested surgeons to any great extent. Even those surgeons who have discussed at some length "the acute abdomen,"[7,8] do not give acute coronary occlusion as a factor in differential diagnosis. Their medical confreres, however, have been keenly aware of its importance in the diagnosis of upper abdominal pathology, especially when it is to be differentiated from gall-stone colic, perforated gastric ulcer and acute pancreatitis. The "acute indigestion," so commonly spoken of in the lay press as a cause of death, is probably, in a high percentage of cases, due to coronary thrombosis.[9]

Following are reports of two cases of coronary occlusion following operation, occurring in the Surgical Clinic of the University of Kansas.

CASE I.—H. A. V., male, age fifty-eight, was admitted to the Hospital March 25, 1916, complaining of a double inguinal hernia. There was nothing important noted in the past history, except attacks of palpitation of the heart. Positive findings on examination were overweight, artificial eye, pyorrhœa, chronic tonsillitis, irregular pulse with extra systole every three to six beats, blood pressure 160 systolic and 110 diastolic. The urine showed albumin and a few hyaline casts. There was a definite inguinal hernia on each side and hydrocele on the left. The blood count and hæmoglobin were normal.

With beta-eucain one-quarter of one per cent. as anæsthetic, a left herniorhaphy and hydrocele excision were done. Before the operation was finished, evidence of beta-eucain poisoning manifested itself by profuse perspiration, slow pulse, and slow irregular respiration. For twelve hours he had continued respiratory distress, slow, weak pulse and at times Cheyne-Stokes type of breathing. During this time he was given adrenalin and intravenous salt solution. He apparently recovered from the poisoning and the next day was making normal post-operative progress.

On the fourth post-operative day about 1:40 A.M., he raised himself slightly in bed to take a drink of water when he suddenly fell back on his pillow, took four or five stertorous gasps and died.

The pathological report by Dr. R. H. Major is in part as follows:

Heart: "On opening the pericardial cavity there is an excess of clear, straw-colored fluid present. The pericardium is smooth and glistening. The heart weighs 560 grams. There is a marked dilatation of the right ventricle. The wall of the right ventricle measures four millimetres in thickness. The wall of the left ventricle measures one and four-tenths centimetres in thickness. Heart valves are normal. The musculature on section has a distinct brownish appearance. The right ventricle shows numerous small, reddish, pin-point areas just beneath the pericardial covering. The aortic arch shows numerous small atheromatous patches. The opening of the right coronary artery just as it passes out of the aorta shows a complete plugging with yellowish white material. On dissecting out the right coronary artery the main trunk and small branches are found plugged with an embolus and the lumen entirely obliterated."

CASE II.—Y. P., a male, age sixty, was admitted to the Surgical Clinic of the University of Kansas December 19, 1929, complaining of pain in the epigastrium. Three months before admission he had received an injury to his upper abdomen by being suddenly jerked by the handle of a road grader. This caused him to have a sudden pain in his epigastrium, as if something had been torn. Since that time he has had more or less soreness and discomfort in the epigastric region, and has been unable to work. At the time of the accident he was somewhat short of breath but this has disappeared. He gave a history of an umbilical hernia for several years. There was some doubt about a small epigastric hernia following the injury. It was thought best, under the circumstances, to repair the umbilical hernia and explore the upper abdomen to determine if there was a small hernia through the fascia or a rupture of the rectus muscle. General examination revealed no other evidence of disease, except arteriosclerosis. His blood pressure was 95 systolic and 60 diastolic. There was a history of treatment for syphilis a few years ago.

December 20, 1929, a midline incision was made above the umbilicus and the upper abdomen explored. No definite hernia was found through the fascia, although there appeared to be some separation of the fibers of the anterior sheath of the rectus muscles. There was a definite diastasis of the recti muscles above the umbilicus. The umbilical hernia was repaired and the wound closed as usual. Following the operation, his condition was satisfactory except slight delirium which was attributed to amytal. He frequently attempted to get out of bed when there was no one to watch him. On the sixth post-operative day an infection was evident in his wound, with a temperature as high as 103 degrees. This was superficial and was easily drained, and the temperature dropped promptly.

On the eleventh post-operative day, he suddenly awoke with rapid respiration and gasping for breath. He did not complain of pain. The pulse was 100 and regular but rather weak. The blood pressure was 88 systolic and 50 diastolic. There was no cough or evidence of disturbance in the lungs. His color was ashen gray and he appeared quite ill. That day the temperature rose to 103 degrees. The respiration varied from 28 to 35 and was suggestive at times of Cheyne-Stokes type. His skin felt clammy. Examination of the heart and lungs did not reveal any definite pathology except distant, feeble heart sounds. The day following the onset of this trouble, a definite to and fro friction rub was discovered over the heart. The heart sounds were more faint than the day previous. His blood count showed a leucocytosis. A diagnosis of coronary occlusion was made. On the third day, the friction rub disappeared and was not heard again during his illness. For the first two or three days he appeared to be entirely conscious and answered questions rationally. Mental disturbance gradually developed. On the fourth day, following the accident, he became quite cyanotic with Cheyne-Stokes respiration and delirium. Abdominal distention was marked. He had a bilateral positive Babinski and ankle clonus at this time and it was thought he had developed emboli in his brain. On the sixth day it became evident that he was developing a hemiplegia. On one occasion he was quite maniacal and had to be held in bed. He had incontinence of faeces and urine. During his entire illness he had more or less cyanosis. A generalized

œdema developed which grew more marked till death. Evidence of general cerebral emboli gradually developed. His systolic blood pressure varied from 100 to 130. On various occasions electrocardiograph tracings showed nothing diagnostic. He gradually grew worse, and died on the fourteenth day following the accident. A final diagnosis of coronary occlusion and cerebral embolism with hemiplegia was made. Autopsy was not permitted. The immediate cause of death was apparently broncho-pneumonia.

The symptoms of coronary occlusion as given by Dr. Louis Hammon[10] are as follows: "1. The immediate symptoms associated with the occlusion; the anginal seizure: A. Pain; B. Shock; 1. Prostration; 2. Fall in blood pressure; 3. Suppression of urine.

"2. The symptoms associated with the myocardial damage, myocardial insufficiency: A. Dyspnœa; B. Passive congestion; 1. Cyanosis; 2. Pulmonary œdema; 3. Enlarged liver; 4. Albuminuria; 5. Subcutaneous œdema; C. Cheyne-Stokes breathing; D. Feeble cardiac impulse, faint heart sounds, gallop rhythm, murmurs, cardiac arrhythmias.

"3. The symptoms associated with the myocardial infarct: A. Fever and leucocytosis; B. Pericarditis; C. Embolic phenomena; D. Cardiac aneurysm and rupture.

"4. Additional symptoms: A. Nausea, vomiting, diarrhœa; B. Facies; C. Vasomotor symptoms; D. Nervous symptoms."

The close association between angina pectoris and coronary obstruction is well recognized and should aid in the diagnosis of the latter condition.

Discussion.—The two patients here reported were both males, fifty-eight and sixty years of age. Herrick[2] states that the condition usually occurs in men beyond fifty years of age with arteriosclerosis and previous attacks of angina pectoris. Both of our patients had definite evidence of arteriosclerosis, but neither gave any history of angina pectoris. In one case examination revealed an irregular pulse with what were apparently extra systoles and a blood pressure of 160 systolic and 110 diastolic. Blood pressure in the older man was 95 systolic and 60 diastolic and the pulse was regular.

In Case I the operation was done entirely with local anæsthetic. This was followed by definite evidence of beta-eucain poisoning and death occurred on the fourth post-operative day. In Case II one-half per cent. novocain was used followed by gas oxygen and ether. Wound infection followed. Preliminary to the anæsthetic he received 15 grains of amytal, ¼ grain of morphine and 1/200 grain of scopolamine. Evidence of coronary occlusion occurred on the eleventh post-operative day.

It has been stated by Evans[11] that post-operative thrombosis, in general, manifests itself most frequently at an interval of some days after the operation. Probably, if the tenth day be taken as a central point, a large proportion of the accidents occur within two or three days on either side of that point. He notes that the blood platelets rise following operation, reaching a maximum in about ten days and then declining to normal. After operation there is also a rise in blood-fibrinogen, apparent on the third day and persisting until the tenth day. The increase in these two important elements of clotting

following operation serves to explain why surgical patients may develop thrombosis or embolism about the tenth post-operative day. Our Case number II conformed to this rule. We see no reason why this explanation of Evans's should not apply to post-operative coronary thrombosis as well as such pathology elsewhere in the body.

We have no definite explanation to offer for the development of occlusion of the coronary arteries in these cases, other than possibly a thrombosis engrafted upon a preëxisting arteriosclerosis. The beta-eucain poisoning with its accompanying slow pulse and drop in blood pressure in the first case, and the infected wound in the second case, may have been contributing factors. These two cardiac accidents suggest the importance of a close pre-operative heart study, including a careful history concerning the occurrence of anginal symptoms. Such a history was not sought in our cases nor did the patient volunteer any such information.

It might be possible in certain cases to avoid post-operative catastrophe by taking a careful history of the heart condition and by making electrocardiographic studies, especially in patients over fifty years of age with arteriosclerosis. The work of Walters[12] should be noted when considering the prevention of thrombosis following operation. In order to combat the decrease of metabolism, the decrease in blood pressure and the slowing of circulation he has given tablets of desiccated thyroid gland in doses of two grains three times daily. With this treatment he reports a decrease in the frequency of pulmonary embolism.

Bancroft, Kugelmass and Stanley-Brown[13] believe that diet has a definite influence upon the clotting function of the blood. Mills[14] emphasizes the important relation of food intake to coagulability. Coagulability is increased with a protein diet and decreased with carbohydrates and fats. He calls attention to the fact that the platelet count rises just at the time most patients are allowed to begin mild exercise and take a full diet. There is a period when all factors favoring thrombosis are at a maximum; the platelets are greatly increased; increased protein intake increases their tendency to clump and disintegrate; this is further aided by the exertion and moving around, and finally the action of the sluggish circulation is intensified during the first few days of sitting up or getting out of bed.

CONCLUSIONS

In the pre-operative study and examination of males past the age of fifty, it is suggested that a careful cardiac history be taken to exclude angina pectoris as a predisposing cause of post-operative coronary occlusion.

A fall in the blood pressure following operation may be a contributing factor in the development of coronary thrombosis. Every effort should be made to prevent shock by proper selection of anæsthetic and operative technic.

Patients having any evidence of coronary disease should be treated with thyroid gland and careful regulation of diet until the danger period has passed.

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LYMPH EXUDATE AND FIBROUS TISSUE*

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"The artless songs I sing do not deal with anything new or never said before."

These words of Rudyard Kipling are particularly fitting to the topic for this annual address. As the results of inflammation, lymph exudate and fibrous tissue remain today almost as great problems for the surgeon as they were when the processes of inflammation were described by Cohnheim in 1877. Nor do I have any new tales to add to those already told. The object of the discourse is to consider in detail the surgical application of the tales heard before about these tissues.

In surgery, fibrous tissue is an expression of recovery or it is the termination of irritation. To the patient, this scar tissue bears a sort of political relationship, for there are occasions when it is a mighty factor as an ally in the restoration of health, and, just as frequently, it can be found as a determined irresistible opponent to the restoration of function. Without this tissue, surgery would be impossible, and because of it surgery often is impossible.

As a process of repair and a medium for reconstruction, fibrous tissue is indispensable. Every wound, regardless of whether it is closed surgically or heals by granulation, depends upon fibrous tissue for the restitution of its structures or its coverings; in some wounds it provides strength, and in others it furnishes a scaffold for the growing epithelium or endothelium. For the restoration of function, fibrous tissue at times gives up its identity entirely, as, for example, in reconstruction operations fibrous tissue may become converted into cartilage, or in tenorrhaphies it takes on the shape of tendon. Then, too, in other reconstruction operations, fibrous tissue in the form of living sutures reproduces itself to restore anatomy.

Even in its disabling manifestations, fibrous tissue has had its inception for a beneficent purpose. Only in exceptional instances, as in keloid and certain cases of abdominal adhesions, have the reparative forces of the body run wild without undue cause. Many of the other deformities represent the body's efforts to repair destroyed tissue, and we have come to look upon these deformities as the toll the patient must pay for a fibrous tissue reaction to an excessive irritation. It is even possible that, after infections, some surgeons look upon the disabling fibrous tissue as a tribute to their art, in other words, the deformity to them is a proof of a violent contamination which has been cured by surgical procedures.

To cure or improve is the primary object of surgery, but to cure or improve without deformity and disability is the ideal of surgery. Lymph exudate is a vital element in all surgical cures, both as a defensive mechanism and as the progenitor of fibrous tissue. Thus the problem is to control lymph exudate so that there may be cures with fibrous tissue as reparative as in the closure of wounds or in reconstructions. Viewed in this light, we may discover that many deformities are not tributes to surgery, and we will observe that a combination of a woman's touch and other qualities are not the only attributes of a good surgeon. Furthermore, if the surgeon appreciates the qualities of lymph exudate and fibrous tissue, he will understand how to deal with those deformities which have not or cannot be controlled.

My first practical lesson in lymph exudate occurred several years ago, and, though I have mentioned the instance at a previous meeting of this Academy, a repetition of the details still contains a lesson. The patient, a young girl, had weathered an attack of peritonitis of appendiceal origin, only to be faced a few days later by probable death from intestinal obstruction. In spite of morphine, lavage, and abstention from even liquids, the symptoms progressed. I reopened the abdomen and found coils of small intestine matted together in the pelvis and in the right iliac fossa by silvery membranes of exudate. Very carefully and thoroughly, I separated the films, saw the intestines resume their size and closed the abdomen with an absolute confidence that the obstruction was controlled. On the day following the second operation the patient again developed obstruction, on account of which I was forced to open the abdomen a third time. At the third operation, the intestinal coils were found matted together once more, but this time I showed better sense and performed an enterostomy, as the result of which the patient entirely recovered. My error at the second operation consisted in judging those membranes only as mechanical barriers, that is, I failed to think in terms of lymph exudate.

Lymph exudate is the body's first reaction to irritation, be it physical, chemical or bacterial. In the case just cited, if I had remembered this fact, I could have prognosticated the formation of more lymph exudate because the digital separation of the membranes was just another irritant. There is no operation, nor any infection which does not irritate the tissue, and in turn the tissues neutralize the irritant and repair the damage by the formation of lymph exudate. This defensive and reparative mechanism is not alone the pathologist's problem; surgical neglect of it is equivalent to thinking that sutures heal a wound or that drains and antiseptics cure infections, in short, it is the practice of mechanical surgery. The disciples of this school, not so many years ago, in peritoneal infections, were tearing away this defensive mechanism, the membrane which, as Boyd and others have said, "is more offensive to the surgeon's eye than to the patient's tissues." Nor is it necessary to carry on experiments to confirm this statement; a study of the components of the exudate will afford ample corroboration.

What are the constituents of the local reaction to irritation. Leucocytes, yes, leucocytes, and serum, fibrin, macrophages and monocytes—each a separate element but all acting in concert. The leucocytes phagocytose and liberate thrombin. The serum through the antitryptic element prevents any digestion of the tissues that would furnish nutriment to bacteria; also, serum brings opsonins, agglutinins, precipitins and fibrinogen, the latter to unite with thrombin for the formation of fibrin. Fibrin offers a foothold for the leucocytes, it shuts off absorption through lymphatics and, figuratively speaking, it ties the bacteria into knots. When the storm of irritation has passed away, the fibrin remains as a focus for the macrophages, leucocytes and monocytes to nourish and produce fibroblasts; in aseptic irritation Hertzler believes that the fibrin is actually converted into fibrous tissue. Taking infection as a specific example of irritation, we find that the exudate starves the bacteria, impedes their action or destroys them and prevents their toxins from entering into the circulation. What can a surgeon hope to add to such a defense? Obviously, only those measures which will nurture and stimulate the exudate.

However, the common practice of treating infections is based on an utter disregard for fibrin, leucocytes and serum. Pus to most surgeons seems to be an indication that the body defenses have broken down. Here, they say, we will destroy these bacteria by antiseptics, by frequent change of drains or by irrigation. What else do they destroy? Naturally, the defense mechanism, because anything that will kill the bacteria must also kill the white blood cells. If chemicals would kill organisms, one could afford to neglect the exudate. Does an antiseptic sterilize an infected wound?

Sir Almoth Wright has said, "If ever an antiseptic sterilized a heavily infected wound, that would deserve to be announced in all the evening and morning newspapers." Wright's inferences can be confirmed by daily visits to any hospital at the dressing hour. You will see pus pour forth from the same infected wounds day after day in spite of the use of varied antiseptics widely advertised as having a high phenol coefficient. If antiseptics are of value, it would seem reasonable that the abscess cavity should be sterilized when the incision is made, yet rarely is this done. Both Wright and Fleming have shown by experiments on wounds and in test tubes that (1) antiseptics cannot reach the bacteria in the tissue spaces; (2) antiseptics are rapidly diluted by the tissue juices to a point where they are no longer lethal for bacteria; and (3) antiseptics will not act in the presence of sloughs, and have very little action in serous discharges or in the presence of blood.

Antiseptics in infected wounds are not only useless but they are harmful. The destruction of leucocytes by the chemicals is not theoretical. Fleming, in 1919, showed that, with most of the antiseptics then in vogue, leucocytes were destroyed or their emigration inhibited. Fleming also demonstrated that some antiseptics actually increased the growth of bacteria, probably because the trypsin from the dead leucocytes encouraged digestion. The cure of an infection by the use of antiseptics is more

probably due to a generous incision than to a destruction of bacteria. It is possible that more recoveries and less loss of tissues from infections might be procured if surgical procedures did not destroy the defensive exudate.

Since the destruction of bacteria is not feasible, let us return to the proposition that protection and stimulation of the exudate are the rational procedures. Incision, drainage and infrequent change of drains—these measures are the only additions that a surgeon can hope to add to the body defenses. This passive method Wright has called the physiological treatment. Fleming has shown that there is one exception to this rule of treatment, namely, in the flat infected wounds. In this variety of infection a preliminary irrigation by hypertonic salt followed by eusol sterilizes the wound; the salt solution washes away the albuminous material and establishes a watery medium, the best medium for the action of antiseptics; the character of the wound permits the eusol to reach every crevice.

For years, surgeons have been forced to follow the physiological line of treatment in infections of the peritoneum. It is admitted by even the champions of antiseptics that no solution can reach all the recesses within the abdomen. No surgeon would think of using an irritant within the abdomen for fear of destroying endothelium, thereby increasing the absorption of toxins. Morphine, Fowler's position and nothing by mouth might cure some cases of peritonitis, but not many. Passive resistance by incision and undisturbed drainage, in conjunction with the measures noted, gives a high percentage of cures, if the treatment be inaugurated before the body has been overwhelmed by toxins. Here, in one of the most sensitive tissues of the body, are afforded daily examples of the efficacy of the passive treatment of infections.

Passive is not an exact qualifying term to apply to the physiological treatment because the method is actually stimulating and irritating to the lymph exudate. The fundamentals of the treatment, the incision and drainage, are more than mere mechanical procedures. The incision relieves pressure (Devine calls it detensionizing), and there is a resultant transudation of serum, an emigration of leucocytes and a backwash from the lymphatics. The drain, though it is inserted as a means for the egress of pus, also actually stimulates the formation of an additional defense. Let us consider in detail the subject of drains and their relation to lymph exudate.

Paradoxical as it may seem, the excretions from many a drained wound, excepting the discharges of the first twenty-four hours, actually are made possible by the closure of the drain with lymph exudate. Remove from your mind entirely the thought that the drain conveys pus and instead consider the drain in its true nature, a foreign body. Any foreign body introduced *into a tissue space is an irritant which Nature in a very few hours surrounds* by lymph exudate. If the entire circumference of the drain be in contact with tissue there is formed a channel through which pus reaches the surface. Consequently, lymph exudate can make of a drain, to use the words of Marion Sims, "a plug to keep the wound open." Of course, these state-

ments, and those which follow, do not apply when fibrin actually penetrates the substance of the drain.

Now, let us revert to the thought that a drain creates an additional defense; that is, it does something more than prevent pus accumulation. In order for you to get a clear conception of this function, think first of an infection and picture to yourself the central cavity of pus surrounded by Nature's barrier of fibrin, leucocytes, *etc*. Introduce into that pus cavity a drain and then recall to your mind how the drain is excluded by lymph exudate. Now, you should have a mental picture of a wall within a wall or of a lymph exudate ring within a lymph exudate ring. Thus, the drain has been the cause for more fibrin and thereby the lymphatics have been more effectively occluded. Also, the more fibrin there is, the greater will be the surface for leucocyte attachment, consequently the more effective will be the phagocytosis, because leucocytes must be fixed to phagocytose. The addition of fibrin and leucocytes are not the only stimulants to the defense by the drain; there is also a constant out-pouring of serum as long as the drain is in the wound, a phenomenon that Horsley has termed a reversal of the lymphatic circulation. Arguments as to the relative merits of a drain are mere academic exercises when compared to a detailed knowledge of the relation of the drain to the lymph exudate.

Some one has said that it is easier to act than to think, a saying that is pertinent to the subject of drains and lymph exudate. For years and years drains have been pulled out of infected wounds daily without a single thought being given to the fact that fibrin and leucocytes were being destroyed. Mutilation of this defensive barrier results not only in an increased absorption of toxins, but also in a reactivation of the infection. A reintroduction of the drain, it is true, will erect another barrier; also, the re-introduction will kill more leucocytes and destroy more fibrin. The sum of the deleterious effects of pulling out the drain and putting it back will probably be greater than the beneficent results established by Nature in the interim between dressings.

Don't disturb the drain unless absolutely necessary, as has been mentioned, is one of the principles of the physiological treatment of infections. The practice of frequent change of drains is based on the fear that excretions will be dammed up by plugging. Every drain does become plugged, but, if the incision be extensive enough, there is no accumulation of pus; there usually is an increase of excretion through the attempts of the body to extrude the foreign object. If you have ever left packing in a wound for five or six days, or if you have ever seen a forgotten sponge removed from an abscess cavity you know that the foreign body was soft and mushy when removed, and you know that there usually was a profuse discharge until the object was taken out. In peritonitis cases drains are not disturbed and yet there seldom is any accumulation of pus as a result of plugging of the drains. Frequent removal of drains is unwarranted and is just as destructive to lymph exudate as is the use of antiseptics. When the penetration of the

fibroblasts into the lymph exudate imparts a rigidity to the channel, the drain can be changed occasionally or removed gradually without reactivation of the infection and without the production of excessive fibrous tissue.

Finally, in this discussion of drains and lymph exudate, there remains the topic of prophylactic use of drainage in the abdomen. Introduction of a drain to prevent dissemination of leakage is good surgery provided the surgeon realizes that the drain may actually encourage leakage. A drain introduced near the site of an anastomosis will build up additional lymph exudate; it will increase the sogginess at the stoma and the sutures may pull out. For the same reason, in the closure of perforated ulcers, if the subphrenic space is to be drained, be sure that the drain does not pass near the closure; neglect of this detail may be a cause for an abscess in the area that is being drained. If one is to judge from the literature, this principle has been entirely forgotten in the discussion of the merits of ideal cholecystectomy. Bile on the dressings after cholecystectomy with drainage may as well be an argument against the drain as it is in favor of it, in other words, the drain might have been the cause for the cutting through of the ligature. This subject cannot be dismissed without some mention about the relation of prophylactic drainage to adhesions, and it is in cholecystectomy that the topic has been given considerable prominence. Clinical experience has led me to believe that a drain within the abdomen for forty-eight hours, the period of our use of the prophylactic drain, never causes symptoms. Theoretically, the statement is perfectly plausible, because the lymph exudate formation ceases on removal of the irritant, and, at the end of forty-eight hours, there are comparatively few leucocytes and macrophages to nourish and stimulate fibroblasts. In cholecystectomy with drainage, in addition to the theory just given, there is the fact that the drain is the least of the irritants. The sutures used in the gall-bladder bed, the trauma to the free fold of the gastro-hepatic omentum, the ligatures on the cystic artery and cystic duct, the combination of these irritants produces more lymph exudate than does the drain, and, furthermore, the sutures, ligatures and raw area remain long after the drain has been removed. I doubt very much that the lymph exudate from prophylactic drainage is a major malefactor in the formation of adhesions.

So much for the detailed story of lymph exudate in infections, and as yet it is still a story in this presentation. On paper, in the test tube, and under the microscope it seems reasonable that incision and undisturbed drainage best serve the patient's welfare because they protect and irritate lymph exudate. However, bacteriological and pathological findings are just theories to the surgeon, unless he can prove them clinically. The statement "that is not my experience" is a convincing argument against any theory, an argument that can be contraverted only by examples of application of the theory. What are the clinical experiences with the physiological treatment of infection?

During the World War, Morrison, by the use of B. I. P. P. paste and

infrequent dressings, secured results which were said to have been as good as those obtained by any other method. Morrison attributed the effects to some sort of sterilization as a result of the interaction of the paste and the tissue juices; the paste itself had no antiseptic effect; in fact, it had to be sterilized before it was introduced into the wound. Fleming was never able to prove Morrison's theory by experiments in the test tube or in the wound, and he concluded that the good results were due to the infrequent dressings. Furthermore, in 1919, Fleming suggested that some bland substance for the wound packing would give results equally as good as B. I. P. P. Orr has supplied that bland substance in vaseline gauze and has combined it with passive wound treatment more radical than Morrison's. Orr's results have proven that Fleming's deductions were correct.

The physiological treatment of surgical infections, call it the Orr method, or the Morrison-Wright-Fleming-Orr method, gives brilliant results. With a generous incision and a bland greasy substance for wound packing that is not disturbed for ten days or longer, deformities seldom occur after infection. The packing never plugs, and when it is removed there is exposed a healthy, red wound, with little or no pus. Surgeons who have used this treatment know that antiseptics are useless; they have had proof that the ideal cure can be obtained by supporting and controlling lymph exudate. Orr believes that the good results are due to an absence of re-infection by frequent dressings. If re-infection were probable, it is possible also, that the accumulation of the wound secretions on the skin would re-infect, or that the cast and the thick unchanged dressings would cause a washing into the wound of the skin bacteria by perspiration. It is probably more exact to say that there is no re-activation of the wound infection by trauma to the defenses. Whether it be re-infection or re-activation, the end-result is the same: the excessive irritation leads to excessive lymph exudate and fibrous tissue.

Fibrous tissue is the deforming factor after infections treated aggressively. For instance, in a case of acute osteomyelitis that has been treated by antiseptics, etc., there practically always occurs a sinus which is generally supposed to be due to a continued infection. Look at the sinus and see the inverted skin edges, feel the sinus wall and note its firm consistency, excise the sinus and transplant into the gap a flap of soft parts and see it heal up (as Reid and others have done), and you will be forced to the conclusion that the peristing sinus is due to the fibrous tissue. Or take a sinus in the soft parts after an infection that was treated similarly to the osteomyelitis, and if you strap the sides of that channel together, healing will occur in a few days; the cause for the drainage was due to the fibrous tissue that prevented collapse of the channel. You may well ask, if the sinus in osteomyelitis be due to fibrous tissue, why does sequestration, a remnant of the infection, so frequently occur? Sequestration and sloughing tendons, we have been taught, are due to a destruction of the blood supply by the infection. When you have seen

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cases of acute osteomyelitis heal without sequestration after treatment by the physiological method, you will have reason to doubt that the infection is the only factor in destruction of the blood supply, or even an important factor. Before infection *per se* can be condemned for the sloughing tendons and the sinuses, it must be proven that granulation tissue is blameless. Granulation tissue is known to destroy cartilage and bone in arthritis, and, in spite of the recent reports on parathyroid hyperplasia, it is probably the source of destruction in osteitis fibrosa cystica, local or diffuse. Granulation tissue is in excess wherever there is prolonged infection or irritation; therefore it is excessive in the old method of treating infection. Granulation tissue attached to any structure will shut off, by its bulk, the blood supply to that structure and this is the probable source of bone and tendon destruction after prolonged infections. This statement could be classed as rank heresy were it not for the fact, as previously mentioned, that sequestration and sloughed tendons seldom occur in the physiological treatment; that is, they are uncommon where there is a minimum of irritation and granulation tissue. If further proof be needed, cut away the fibrous tissue and granulation tissue, close the wound so that there will be no further irritation and see the wound heal without sequestration. In terminating this discussion on lymph exudate and its value in infections, let it be noted that skill is not essential to the ideal cures, and that deformities are not an index of the severity of an infection.

The lymph exudate of repair has the same qualities as the lymph exudate of defense. When the storm of infection has cleared away, and, to some extent during the infection, the defensive barrier changes to a reparative medium. The fibrin forms the scaffold for the ingrowing fibroblasts and the sprouting blood-vessels; thus, there comes into existence the granulation tissue. At first, the fibroblasts and the blood-vessels lie parallel to each other and at right angles to the surface of the wound. After organization is completed, the cells and fibrils have changed to a direction parallel to the surface of the wound, the blood-vessels have become obliterated and the cells have shrunk. Whether the fibroblasts spring from fibrous tissue, or from the polyblasts or the monocytes, seems of less practical importance than is the final arrangement of the fibrous tissue bundle.

Every soft pliable scar has the fibroblasts and fibrils arranged parallel to the surface of the scar, whereas, in adhesions and in some contracted scars, the bundles are at right angles to the coverings, the primitive arrangement in healing. Horsley, in his study of cicatricial contractures, came to the conclusion that there were no histological differences between the contracted and non-contracted scar, though he did note that in the contractures fibroblasts were found in an arrangement at right angles to the epithelium. Could it not be that it is just this difference in polarity of the cells that accounts for the tendency of scars in certain regions to contract?

Longitudinal incision in the neck, elbow, hand, axilla and popliteal space—all of them have a tendency to contract, regardless of whether there has

been healing by so-called primary intention or healing by granulation. These contractures stand out in whiplike cords and they mechanically impede motion. Inspection of these cords shows that the fascia in the region of the scar is pulled out beyond its surroundings. This traction outwards could be explained by the arrangement of the fibrous tissue bundles at right angles to the skin, an arrangement that would cause the fascia to be pulled up and out when the scar tissue contracted at organization. Why should the bundles have a different arrangement in contractures? Bunting and Eades may have answered this question by their experiments in which they were able to change the arrangement of the fibroblasts by changing the lines of traction on a wound. If they applied traction perpendicular to a wound, fibroblasts assumed that direction; if the traction was parallel to the line of the wound, the fibroblasts were in the same direction; if the forces were radial, the fibroblasts were also radial.

Now, it seems to me theoretically probable that muscle- and tendon-push on the skin determine the contractures mentioned. Feel your own antecubital fossa when the elbow is flexed and you will notice how the biceps tendon stands out like a cord and pushes up the skin. If there were a longitudinal wound in this region and if the elbow were held at a right angle or if it were moved frequently before organization, the fibroblasts would, according to Bunting and Eades' experiment, lie at right angles to the wound, and, after organization, they would pull out the deep fascia into a band. Or, again, abduct your shoulder and note how the axillary fold muscles make a downward traction on the skin of the axilla, and this is another site of weblike bands. I have noted, though it may be a coincidence, that none of the radical operations for carcinoma of the breast have contractures, and I have assumed that this was due to the removal of the axillary fold muscles and to the splinting of the arm against the chest.

What is the practical application of this knowledge of traction? First, of course, use transverse scars in the regions noted. Incidentally, you may wonder why traction does not affect the latter wounds. I believe that it is due to this fact, that the traction or push out in the center of the wound is neutralized by the pull in or transverse pull at both extremities. To return to the applications, incisions are not always surgical, and there are other injuries, such as burns. If traction be a factor in contractures, it would seem reasonable that in destruction of tissue in the axilla, the arm should be held against the side to eliminate the muscle-push and then depend on later stretching of the fibrous tissue to restore abduction. Also, in burns of the chest and neck, immobilization of some sort might prevent motions that make for contractures by taut muscles. When wounds occur longitudinally in the surface flexures, motion should be prohibited until after four or five weeks or until the fibroblasts have become settled in a line parallel to the scar.

The lymph exudate of primary healing requires very little discussion. The sutures and splints we employ insure healing from lymph exudate

through granulation, so that any defect is usually the result of mechanical error. However, there is some profit and considerable mental diversion secured by translating sutures, *etc.*, *into terms of lymph exudate.*

Every surgeon knows that the best cosmetic result is secured by the use of non-absorbable material. The answer is found in the fact that the absorbable suture is a greater irritant and more of a foreign body than the silkworm and like materials. Catgut requires more lymph exudate and requires it over a longer period of time because it is not removed, therefore, with these sutures, there will be more fibrous tissue.

In suturing, one should remember that every stitch more than required is a double irritant; first, by means of the extra foreign body, and secondly, through the trauma of introduction of that foreign body. If, as seems probable, purse-string sutures in appendectomy be unnecessary, then the practice of burying the stump should be abandoned, not on account of the change of form in the cæcum, but because of possible fibrosis and adhesions from unnecessary trauma. On the other hand, extra irritation and added trauma might be of advantage, as in herniorrhaphies; here many sutures closely placed will secure a firmer bond between the muscles and Poupart's ligament than will a few sutures. Likewise, close suturing of the abdominal wall is an added protection against prolapse of the intestines or a stretching of the scar. The use of many sutures in gastroenterostomies in order to prevent leakage may be unnecessary. It is probable that leakage would not occur provided the surgeon made use of interpolation—if only one line of sutures were used—because, as Hertzler has demonstrated, the interstices between the sutures are filled with lymph exudate in a few hours. This observation explains the absence of gastric juice leakage after this operation and accounts for the safety of water administration in small amounts by mouth after twelve hours.

The purpose of sutures is to hold firmly the lymph exudate scaffold. The suture material is absorbed or removed before the scaffold has disappeared and before the fibrous tissue has organized. It is in the interim between lymph exudate and fibrous tissue, between suture and organization, that great care is required. This is the period when we must guard not only against what the patient may do, but also against what others might *do to the patient.* Garlock had this danger period in mind when he advised early active motion and counseled against passive motion following tenorrhaphies. He knew, for instance, that the finger movements would be commensurate to the strength of the exudate bond, whereas the masseur might tear that bridge away.

Every discussion of lymph exudate is more or less intertwined with the subject of fibrous tissue, but a discussion of fibrous tissue does not of necessity involve lymph exudate. Fibrous tissue also springs from bloodclot, a formation in which lymph exudate is a secondary factor. Elimination of blood-clot is another method of fibrous tissue control. Some few years ago, Owen, at one of these meetings, showed some excellent functional re-

sults obtained by the frequent tapping of hemarthrosis of the knee. From experience, we all know that blood left in a joint will clot and organize, with the result that there will be impeded motion by the mass, or ankylosis from destruction of the cartilage by granulation tissue. Organization of blood also occurs in the largest endothelial cavity, in the peritoneum, and to leave clots here is an invitation to the formation of fibrous tissue.

Fibrous tissue and lymph exudate are not related problems when the deformities come to the surgeon in full bloom. Then, control is no longer possible; the solution can be secured only by stretching or collapsing the wall. If one attempts forcibly to break up the adhesions, then there ensues another process of granulation and organization.

The treatment of fibrous ankylosis of joints is a prominent example of what stretching can do as opposed to what breaking adhesions will cause.

The dramatic procedure of breaking up joint adhesions under anæsthesia is brutal and useless. Reverse Hunter's formula and "think—don't try," and you will never use this method. Breaking up adhesions means bleeding into and around the joints, more fibrous tissue and aggravated ankylosis. Clinically, after these procedures, the joints are swollen and, in the end, the patient has less motion than at the beginning of the treatment. Put these cases on gradual stretching by plaster casts or by traction apparatus and a fairly good functional result will be obtained in many cases.

Stretching of adhesions, a stretching that is persistent, is an occasional cause for disability and pain. I have in mind the adhesions about the subastragalar joint after fracture of the os calcis. The efforts of surgery in this instance are directed against further stretching by abolition of the joint motion through arthrodesis.

Stretching is a big item in the surgery of fibrous tissue; sometimes we use it; occasionally we abolish it, and frequently in abdominal wounds we guard against it by the use of belts. In the abdomen, for fibrous tissue to be truly reparative, it must be a narrow, firm band that joins together gaps in the muscle or fascia or joins muscle and fascia. Where the scar is thin and wide, a belt might be of service if it could prevent lateral traction on the scar, which it rarely does. If the patient be very fat, then the belt does re- duce stretching by preventing pressure from the inside. However, to consider the belt as a protection against muscle-pull is a delusion, because when the patient is stooped over, as in the act of lifting, two hands can be inserted between the belt and the belly. For the linear scar, the belt gives comfort to the patient but nothing else, for be it remembered, that these scars be- come organized in three weeks.

The most efficient treatment of fibrous tissue is that which has for its object the excision of the scar or the collapse of the sinus wall. Already, this treatment has been noted with respect to the sinuses of osteomyelitis, and it is the principle behind thoracoplasty in chronic empyema. Fistula in ano is also a sinus encircled by fibrous tissue; if it were possible to strap the sides of this channel together, healing sometimes would occur without opera-

tion. Incision of the roof of this quasi-fistula results in healing, though delayed healing, by a collapse of one part of the fibrous tissue. Excision of the entire tract and immediate closure of the wound, as is done in Ashhurst's clinic at the Episcopal Hospital, gives a rapid cure, and a union by adhesion in the majority of the cases. The prolonged dressings for many sinuses could be prevented by excision of the entire fibrous tissue barrier.

What about the fibrous tissue riddles of keloid and peritoneal adhesions? Whoever solves keloid will answer the question of tumors and their related subjects of tissue tension, internal secretion, growth and inherited properties. As for abdominal adhesions, it does not seem probable that any substance introduced into the peritoneal cavity will prevent their growth, since even physiological salt solution within the belly is a cause for a leucocyte emigration.

At the end of the scale, I have placed non-union of fracture. Cowan's brilliant work seems to show that non-union is the result of fibrous tissue, and that the fibrous tissue does not represent an attempt at bone repair. By experiments on dogs, and by clinical observation, Cowan came to the conclusion that the fibrous tissue from the periosteum grew between the bone ends because the fragments were separated. This band, he reasoned, grew faster than the medullary callus could fill the gap, and it succeeded in holding the bones apart. Perhaps this difficult complication will be solved by the simple method of excluding the periosteum, as Cowan has done, when operating on cases of non-union.

I might continue for some time this theorizing and recital of old tales, but I fear that I would be committing the error of repetition of details. Details are all I have had to bring you, for which I have, as excuse, the saying attributed to Michelangelo that "success is due to details, but success is no detail."

METASTASIS OF THYROID TISSUE TO ABDOMINAL ORGANS

WITH SPECIAL CASE REPORT OF A STRUMA OVARII METASTASIZING TO THE OMENTUM

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Thyroid tissue is found from time to time in places other than its proscribed location in the neck. There are three possibilities for its ectopic occurrence. Vestiges of thyroid anlage may be dropped during embryonic development all the way along the course of the normal thyroid invagination, from the mediastinum to the root of the tongue. Thyroid tumors may develop from these rests. Cellular anlages of thyroid tissue may also be displaced during development to appear in more distant parts, for example, in the ovary. Here it is usually associated with other elements, arising from similar, embryonically displaced but multipotent cells, or it may appear alone.

In later life, thyroid tissue may metastasize and implant itself in other situations, such as the lungs, bones, adrenals, etc. The stimulus to metastasize may be referred to the development of a frank carcinoma of the thyroid. A struma proliferans of Langhans' type may also break into the thyroid veins and be carried to distant organs. But such scattering of thyroid tissue in later life does not necessarily always imply the histologic characteristics of malignancy. Even a morphologically benign goitre may send out metastases which are in turn just as apparently benign as the parent tumor.

Ectopic thyroid tissue, wherever it be, is invested with the same potentialities as the thyroid gland in the neck. It may proliferate. It may grow and spread into adjacent tissue. It may become carcinomatous. Like the struma colli, with or without histological evidence of malignancy, it too may send out metastases.

In a case which I recently had the opportunity to study, in addition to a benign nodose struma colli, there were numerous goiterous nodules scattered in the omentum and on the intestinal serosa, and ectopic thyroid tissue was also found in an ovary. Metastases in later life from a struma colli, be it benign or malignant, have been described repeatedly in many organs, including those of the abdomen. But never, as far as I could find, have they been reported in the omentum. Embryonically displaced thyroid tissue has often been recorded in the ovaries, but never primarily within the peritoneal membrane. Primary tumors of the ovary are however particularly prone to peritoneal metastases. It is suggested therefore that the goiterous nodules in the omentum had come not directly from the struma colli, not as embryonic displacements of thyroid anlage, but as late secondary peritoneal metastases

from the benign, embryonically displaced ectopic thyroid tissue found in the ovary.

CASE REPORT.—*Clinical history.*—A colored female, thirty-eight years old, entered the Cook County Hospital with the complaint of a progressive dyspnœa of five months' duration, which had become suddenly worse in the last two weeks. She began gradually to pass large amounts of urine, and had to get up five or six times a night to urinate. Her vision began to fail rapidly. She felt tired and weak, lost about twenty-five pounds in weight, and in the last few weeks had vomited frequently.

Her past history included three spontaneous abortions, each late in pregnancy. Twelve years ago, at the Jane Terrell Hospital in Memphis, Tennessee, a left oöphorec-
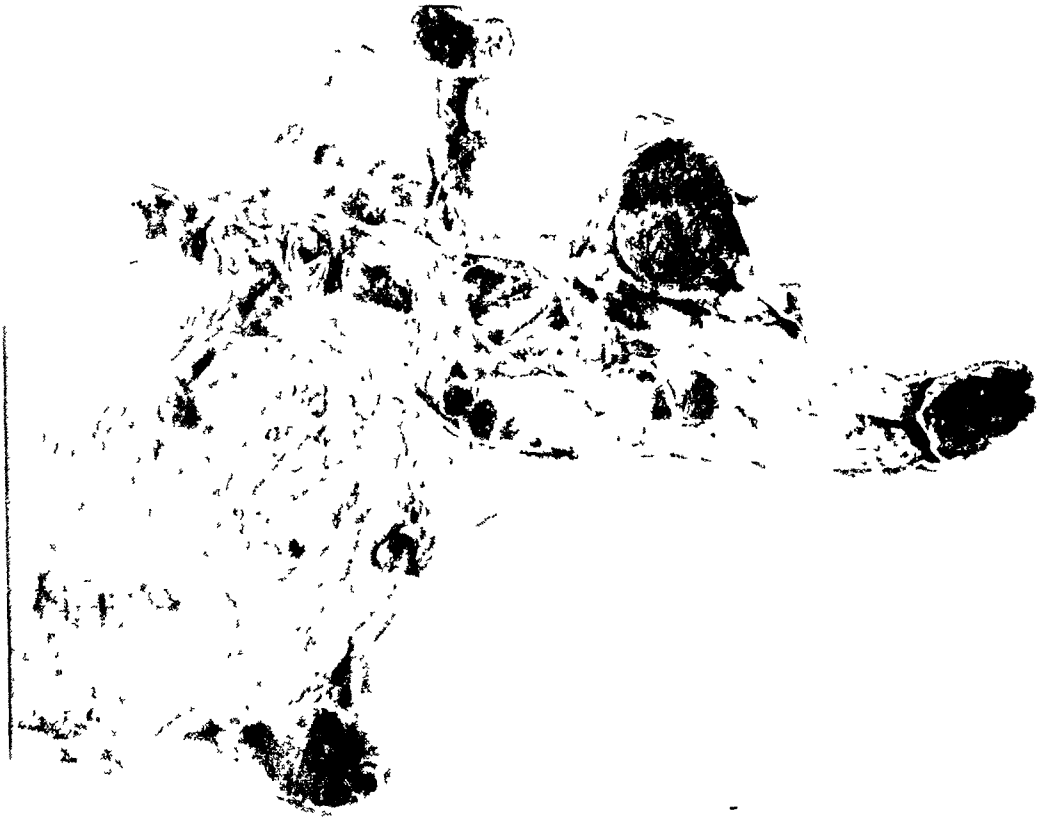
FIG 1 —Nodes of thyroid tissue in the greater omentum

tomy had been performed. The ovary was large and cystic, but, grossly at least, showed nothing extraordinary. At the time, nothing unusual was noted in the omentum or anywhere else in the abdomen.

Physical examination—On admission, she was drowsy, listless, disoriented except for brief, lucid intervals in which she could collect herself sufficiently to answer questions. Her pupils were irregular, unequal, fixed to light and accommodation. Conjunctivæ and finger nails were pale. Knee jerks were present.

The blood pressure was 198/128. The heart was markedly enlarged with its apex beat in the sixth interspace, and the left heart border in the anterior axillary line. The aortic second sound was roughened. Dullness, loud breath sounds and crackling râles were found over the right lung. Nothing at all was palpated in the abdomen.

The Kahn reaction of the blood was negative. There was a moderate albuminuria with a few granular casts. Blood chemistry returned a urea nitrogen of 151 milligrams/100 centimetres, and a creatinin of 10. Fundus examination showed a bilateral papilledema. Terminally a uremic "frost" appeared on the skin.

Clinical diagnosis was: 1. Primary contracted kidneys with uræmia; 2. Hypertensive heart disease; 3. Syphilis.

Autopsy (by Dr. R. H. Jaffé).—The complexity of the pathological findings and the possibilities of varied interpretation, warrant a detailed description of this case. In the midline

External description.—The body was that of a poorly nourished colored female. In the midline of the abdomen, there was an ancient, healed, infra-umbilical, laparotomy scar, 13 centimetres long.

Abdominal cavity.—The lower border of the omentum was attached to the anterior abdominal wall at the site of the laparotomy scar, and to loops of lower ileum. Scattered over both surfaces of the greater omentum were numerous spherical nodules. They varied in size from the smallest, 1 by 5 millimetres, to the largest, 35 millimetres in diameter. They were firm, and, grossly, sharply distinct from the omental fat tissue.

On surfaces made by section there was a great variety of structures. Some of the nodules were light brown, finely granular and somewhat translucent, resembling thyroid tissue. The larger nodes showed a deep purple-red mottling, and opaque, light yellow-gray, irregular areas up to 1 by 4 milli-metres in diameter. One of the nodes, 3 centimetres in diameter, had a firm, whitish capsule and a soft, medullary, light grayish-brown centre. Similar nodules were found in the mesentery along the small intestine. These were much smaller, 3 to 5 millimetres in diameter. Attached to the upper ileum was a single, larger, thyroid-like nodule 15 millimetres in diameter. In

Thyroid.—Forty-four grams in weight. The right lobe measured 7.5 by 3.5 by 2 centimetres. In the lower pole was a sharply circumscribed, ovoid node 2.5 by 2 by 2 centimetres in diameter. It was mottled light brown-gray and deep purple-red, and had a distinct white fibrous capsule. The left lobe measured 5.5 by 2 by 1.9 centimetres. In its lower pole also was a spherical, sharply circumscribed,

FIG. 2.—Left and right lobes of the thyroid gland, with multiple metastases.

9 millimetres, finely granular, purplish-brown nodule. In the isthmus of the thyroid was a similar nodule 8 millimetres in diameter. The remainder of the thyroid tissue was light pink-gray, finely granular, with single, firmer, lighter areas up to 5 millimetres in diameter. Grossly, no invasion of the thyroid veins by these nodules could be found.

Ovaries.—The left ovary was 4 by 3 by 3 centimetres in diameter. It was firm, but contained several cysts from 1 to 16 millimetres in diameter. There were also more solid, light grayish-brown, fibrous adhesions. The ovary was composed of firm, grayish-white tissue. The remainder of finely granular, somewhat translucent areas up to 5 or 6 millimetres in diameter. The right ovary and Fallopian tube were imbedded in the ovary was pale.

Heart.—418 grams. Left ventricle 20 millimetres thick, right ventricle 4 millimetres. The myocardium was composed of firm, grayish-brown, streaked with yellow. Surfaces made by section were purplish-gray, and very

Aorta.—Focal areas of irregular, intimal wrinkling in the supravalvular portion.

Lungs.—The left lung had three lobes. The right lung showed, in addition, in its lower lobe, numerous gray, moist with frothy fluid. The right lung showed, in addition, in its lower lobe, numerous gray,

Stomach.—Firm areas of consolidation.

Spleen.—170 grams. The mucosa was deeply injected, and covered by much, thick, yellowish-gray mucus. granular areas of consolidation.

Kidneys.—Cortex light gray. Markings obscure. *Pancreas.*—90 grams. Firm, purplish-brown mottled with together. *Liver.*—1700 grams. Light yellow-gray. *Adrenals.*—19 grams

Kidneys.—Cortex light gray. Markings obscure. *Pancreas.*—90 grams. Firm, purplish-brown mottled with lar surface. The granules were light gray. The capsule stripped with difficulty leaving a finely granu-millimetres wide, mottled purple-gray and light gray, separated by dark purple lines. The cortex was 5 a cyst 3 centimetres in diameter. The pelvic mucosa was pale gray. In the medulla of the right kidney there was patches.

Brain.—1400 grams. The convolutions were slightly flattened, the leptomeningi deep purple substance was soft and wet. The internal carotid arteries were stiff-walled with numerous hyalin plaques.

Hypophysis.—In the roof of the sella turcica, there was a circular opening of the dura mater, 10 millimetres in diameter. The hypophysis was atrophied, its superior aspect sunken, so that the gland formed a saucer-like disc in the floor of the sella.

MICROSCOPIC EXAMINATION. 1. *Thyroid.*—All parts of the thyroid gland were sectioned.

a. Right lobe: The large node was separated from the remaining parts of the thyroid by a distinct capsule of fibrillar connective tissue. The capsule was of varying thickness, but nowhere was it interrupted. The node was composed of follicles of varying size which were separated into irregular groups by a stroma of dense, hyalin connective tissue. This fibrous tissue was most abundant near the

FIG. 3.—Thyroid tissue and cysts in the right ovary.

central portions. In each group of follicles one type usually predominated. There were groups with very small follicles with narrow lumina which were either empty, or contained a pale stained material. The lining of these was regular, cuboidal, and the cells contained round nuclei with a fine net of chromatin granules.

As the follicles increased in size, the lining became lower, and the content showed a greater affinity for the acid stain. The largest follicles sometimes showed a central basofilic and a peripheral oxyphilic colloid. There were follicles with recent hæmorrhages in the lumen. Others showed large mononuclear cells filled by blood pigment or lipoid droplets. Some of the follicles contained small, basofilic droplets with lipoid granules suspended in a light stained basement substance (spheroids).

In the stroma there were many recent hæmorrhages, and remnants of such in the form of brown hæmosiderin deposits. In a few places the stroma contained small granules of calcium. A large artery entering the node had a much thickened intima with an extreme narrowing of the lumen. Outside the node, the thyroid was uniformly composed of medium-sized, colloid-filled follicles which were arranged in regular lobules. These were separated by a slightly increased amount of stroma. In the upper pole was another small, encapsulated, 5 millimetre nodule. It was composed of small, medium-sized, and large follicles filled by colloid, and lined by a regular epithelium. The isthmus was of similar structure.

b. Left lobe: The large node resembled that described in the right lobe. In addition to it, there were several smaller nodules. They were made up of small and medium-sized follicles. But one of these nodules contained, in addition to the follicles, a small area which was composed only of *anastomosing cords of regularly shaped, small cuboidal cells.*

In no place in the entire gland, not even in the nodule containing the

FIG. 4.—Left lobe of thyroid gland. Nodule with trabeculæ resembling Langhans' type of proliferating struma. Hemotoxylin and eosin. Leitz apochromat 4 millimetres, periplanar 4.

anastomosing cords of cuboidal cells, was there any invasion of the veins by thyroid tissue. The lumen of the veins was wide open and empty. In no place in the thyroid, was there any infiltration of the capsule.

2. *Nodules in greater omentum.*—Several nodules were sectioned. All answered essentially to the same histologic description. Each nodule was separated from the mesenteric fat tissue by a thin and continuous capsule of connective tissue. In places the nodules extended to the free surface of the omentum. They are composed of oval or branched, elongated spaces separated by thin strands of fibrillar connective tissue. Some of these strands were thick, hyalinic, and contained much dark brown pigment engulfed by cells. The spaces varied from twenty-five to several hundred microns in

diameter. Their content was pale, homogeneous and oxyphilic, similar to that of the thyroid. At times it was hæmorrhagic, or showed the remnants of hæmorrhages in the form of fatty acid needles, and free vacuolated and pigmented mononuclear cells. The majority of the spaces were lined by very fat or by low cuboidal epithelium. There were, however, places in which the epithelium was high cylindrical, slender, with basal round nuclei. This epithelium sometimes lined only part of a follicular space, while the rest was lined by flat epithelium. The portions with the high epithelium often pro-
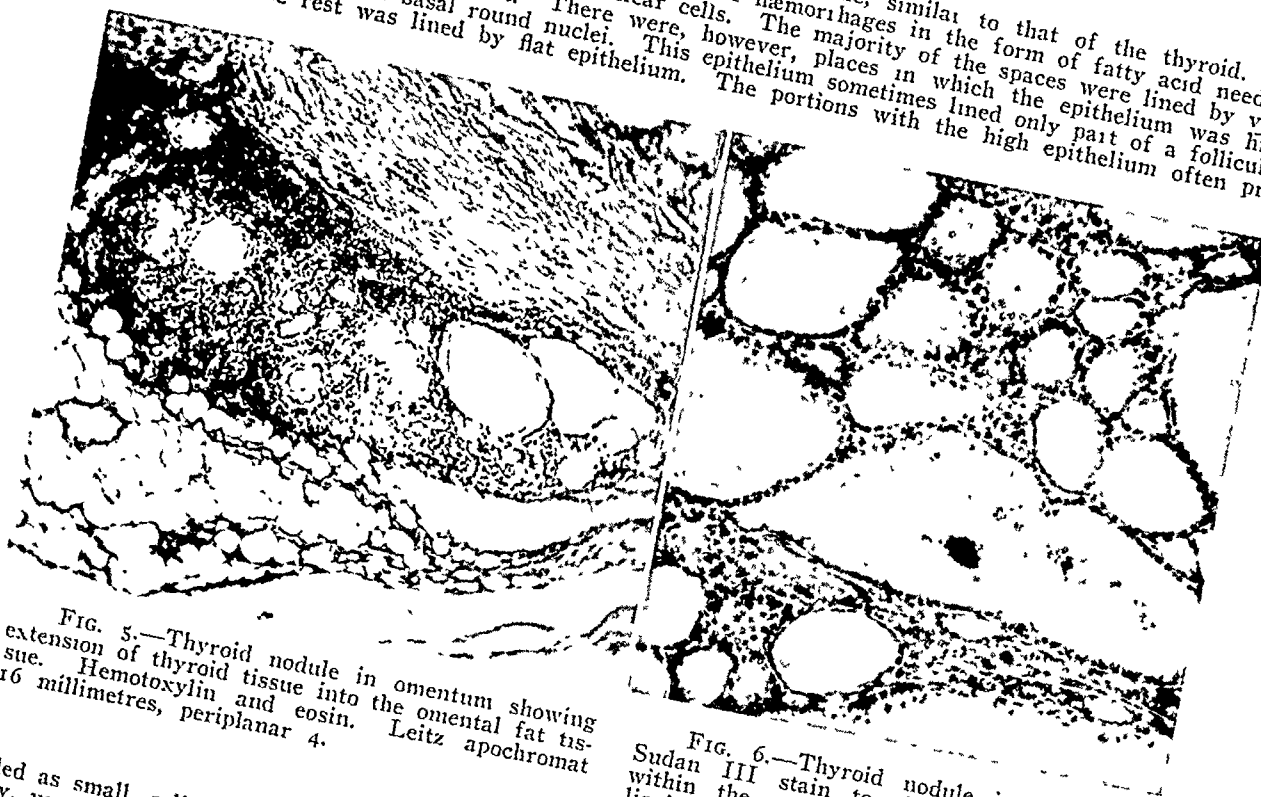
FIG. 5.—Thyroid nodule in omentum showing extension of thyroid tissue into the omental fat tissue. Hemotoxylin and eosin. Leitz apochromat 16 millimetres, periplanar 4.

FIG. 6.—Thyroid nodule in omentum. Sudan III stain to show lipoid droplets within the epithelial cells, and droplets lipoid drop clusters and spheroids, the colloid. Leitz apochromat 4 millimetres, periplanar 4.

truded as small, solid, proliferating masses into the lumen. Adjacent to these protrusions there were many, very small, young follicles. In the periphery of the nodules there were numerous, small, circumscribed accumulations of lymphocytes. In one nodule, though it possessed a distinct capsule, small groups of follicle-like spaces were found, outside the capsule, extending between the adjacent fat cells which appeared slightly compressed. This apparently represented the mode of extension of the nodules. In these places, the interstitial accumulations of lymphocytes were more marked. In the
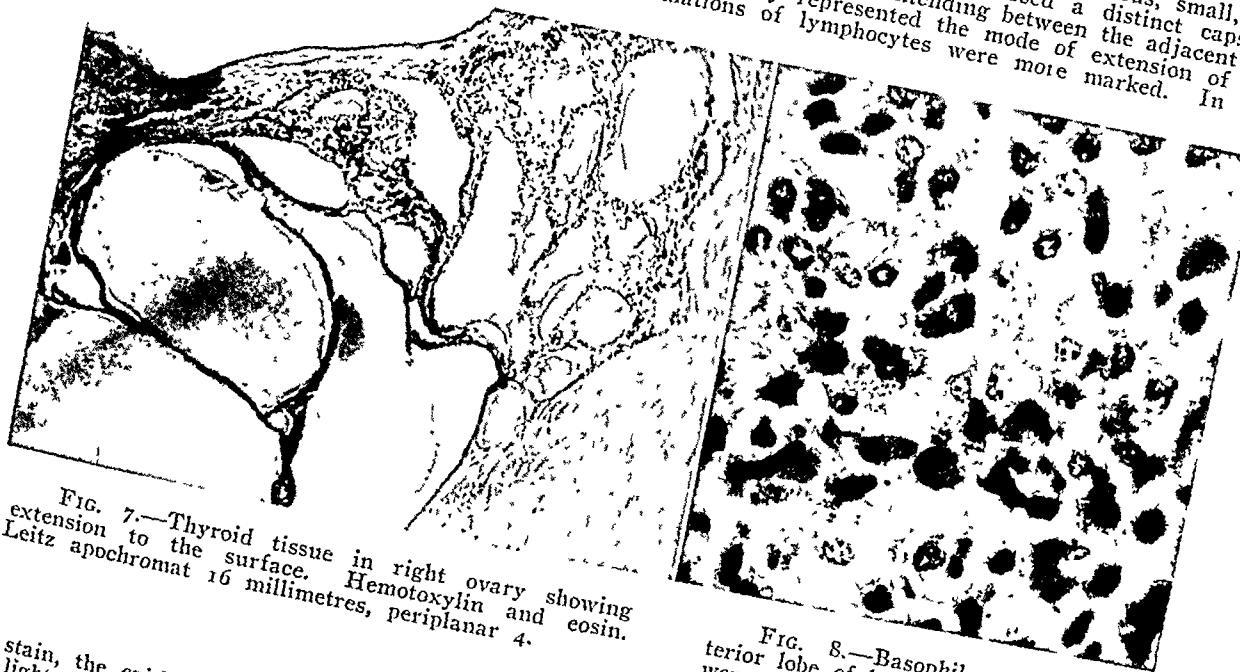
FIG. 7.—Thyroid tissue in right ovary showing extension to the surface. Hemotoxylin and eosin. Leitz apochromat 16 millimetres, periplanar 4.

FIG. 8.—Basophil cells in posterior lobe of hypophysis. These cells were altogether different from the basophil cells of the anterior lobe. Giemsa stain. Leitz apochromat oil immersion 2 millimetres, periplaner 4.

fat stain, the epithelial cells were found to contain a moderate number of small lipoid droplets. In the light stained, colloid-like content of the follicles there was a varying number of small spheroids with fine lipoid granules. Many of the follicles contained extra- and intra-cellular clusters of larger, bright orange-yellow fat droplets. In the stroma also, there were a few branched cells with fine lipoid granules.

Some of the nodules were submitted to Dr. R. W. Webster, coroner's chemist, for examination. They yielded iodine in a quantity equivalent to 8.69 milligrams per 100 grams of dried tumor.

3. *Right ovary.*—Sections were taken from all parts of the ovary. There was only a small amount of ovarian tissue left. It was restricted to the hilus and to a narrow marginal zone adjacent to the hilus. It showed the characteristic stroma with numerous corpora albuginea, thick-walled arteries, and a few small, follicular cysts.

The bulk of the ovary was composed of thick, wavy, hyalin masses which in places were loosened, and contained various-shaped and various-sized cavities which appeared empty. These masses surrounded groups of other round or oval spaces from 50 to 200 microns in diameter, filled by a homogeneous, colloid-like, pink-stained material. The spaces were lined by a very flat and indistinct epithelium, in which no goblet cells were found. Some of these spaces contained foamy cells, and cells filled by light brown pigment. The larger spaces were lined by flat epithelium, the smaller by low cuboidal epithelium resembling that of the thyroid. In places these follicle-like spaces extended to the surface of the gland.

With Kraus' modification of Unna's polychrome-methylene blue, acid fuchsin-tannic acid stain,[1] the follicles described in the thyroid, in the omental nodules, and in the ovary were all revealed to be filled by the same blue and bluish-violet homogeneous colloid. By this differential stain the colloid of the thyroid, of the omentum, and of the ovary were found to be *tinctorially identical.*

4. *Hypophysis.*—The anterior lobe showed no essential microscopic changes, except for a slight increase in the interstitial tissue. Adjacent to the zona intermedia, and occupying the inferior half of the posterior lobe, there was a well-defined area composed of cords of polyhedral or cylindrical cells. These cells resembled none of the anterior lobe types. They had a finely granular, purple-pink cytoplasm, in contrast to the deep purple cytoplasm (Giemsa stain) of the anterior lobe basofils. Their nucleus was eccentric, round, with many fine chromatin granules. Posteriorly these cords radiated into the glia, became separated from one another, and gradually disappeared.*

5. *Lungs.*—Microscopically, no evidence of thyroid metastases could be found in the lungs.

6. *Kidneys.*—There was a severe arteriosclerosis, with many hyalinized glomeruli. Single glomeruli showed distinct capillary dilatation, others an actual fibrinoid necrosis which extended into the afferent and intra-lobular arterioles.

The adrenal arterioles showed also a marked thickening of their intima. In the liver and spleen there was diffuse capillary dilatation. The bone marrow was very cellular with active granulo- and erythro-poiesis. The aorta offered the typical histologic picture of a syphilitic aortitis.

Anatomical Diagnosis.—1. Malignant nephrosclerosis with arteriolo-necrosis. 2. Eccentric hypertrophy of the heart and fatty degeneration of the myocardium. 3. Syphilitic aortitis and atheromatosis. 4. Nodose goitre. 5. *Struma ovarii* of the right ovary, with multiple metastases to the greater omentum, mesentery and visceral peritoneum. 6. Confluent bronchopneumonia of the right lower pulmonary lobe. 7. Œdema of the brain. 8. Absent left ovary, and ancient laparotomy scar.

DISCUSSION.—The essential clinical picture and the cause of death was malignant nephrosclerosis, ending in uræmia. The thyroid nodules scattered through the abdomen were benign incidental findings. By their size and encapsulation it was apparent that the nodules had been in the abdomen for some time. They might have remained there for many years more without causing any disturbance, had not the renal involvement prematurely terminated the case. The omental nodules had nothing to do with her illness or death.

That these benign nodules were really thyroid tissue, was readily demonstrable. Grossly they looked like goiterous nodules. Histologically they were identical with the nodose goitre in the neck. They answered to the classical description of a simple, macro- and micro-follicular, nodose colloid goitre. They showed the same degenerative and hæmorrhagic changes which were found in the struma colli. They showed the same papillary and proliferative epithelial changes which are typical for any growing nodose goitre.

The colloid they contained was tinctorially identical, by Kraus' stain, with that of the thyroid in the neck. Fat stain revealed in this colloid, the lipoid clusters and foam cells and spheroids which are characteristic of thyroid tissue. These lipoid droplets are the products of secretory activity of thyroid epithelium (Jaffé[6]). Their presence in the omental nodules ascribed to this tissue the same thyroid function character. Finally, iodine was demonstrated chemically in ample quantity, from sample nodules. The

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* These cells in the posterior lobe were only an incidental finding, but are described in detail because they correspond to structures which Lœffler,[2] and Maurer, Lewis and Lee[3,4,5] have recently emphasized. They are not inwandering cells from the anterior lobe, but are special differentiations from the posterior wall of Rathke's pouch. If man has a pars intermedia, these cell groups represent the closest approximation to it.

presence of this iodine indicated also the possibility of thyroid function. From all these lines of evidence it was clear that the omental nodules were really thyroid tissue.

The question then arose as to how these thyroid nodules had gotten into the omentum. They might have come from a frankly anaplastic thyroid carcinoma in the neck. Histologically, the omental nodules were altogether benign. But thyroid carcinoma metastases, though usually malignant, have a tendency to assume more mature character, and appear benign. Even these apparently innocent secondary nodules in the omentum might still then have come from a malignant primary tumor in the neck. But histologic examination of sections from every part of the nodose struma colli failed to reveal the slightest evidence of malignancy. There was not the smallest focus in it, for definitely malignant spread.

With carcinoma excluded, the omental nodules might still have come from a struma proliferans of Langhans' type. Langhans described a type of metastasizing goitre which could be distinguished both from carcinoma and from benign glands.[7] They are composed of anastomosing cords of cuboidal cells. They tend to break into veins, and thus metastasize by way of the blood-stream, to set up similar nodules in distant organs.[8] They offer a possible source for thyroid metastases other than the ordinary carcinoma.

Only in one of the sections from the left lobe of the thyroid was there found a very small area of these "anastomosing cords of cuboidal cells." That these cords were responsible for sending out the thyroid metastases was unlikely. They were apparently quite a recent development, unquestionably younger than the nodes in the omentum and ovary. They did not break into the thyroid veins, and nowhere in the omental nodules was there found any reproduction of the solid, cellular cords.

With a struma proliferans also excluded, it was still possible for a simple, nodose struma colli to have sent out the benign metastatic nodules. Cohnheim, in 1876, first described a case of this type.[9] Great controversy has raged since then about the true nature of these so-called, "Benign Metastasizing Adenomas" (see Simpson,[10] Ewing,[11] Alessandri,[12] Pool[13]). Many cases have since been reported, but Wegelin[14] accepted only fourteen from the literature as being histologically adequately proved, benign metas- tases from benign goitres.

Histologically these goitres look benign. The sections from the thyroid gland in these cases would be altogether indistinguishable from the hundreds of nodose goitres examined routinely and dismissed as benign. Yet they metastasize. Graham[15] therefore indicated that in these cases, benign cellular structure could not be used as a reliable criterion. A nodose goitre might appear quite benign. But if it showed invasion of the capsule, or particu- larly the thyroid veins, it could—though it necessarily need not—give rise to metastases.[16] Even in the first cases described, Cohnheim had observed this. But no such invasion could be found in the case here reported. Nowhere, throughout the benign gland, were there any goitre nodules break-

ing through the capsule, or into the thyroid veins. There were no histologic findings upon which to accept, readily, the struma colli as even a benign metastasizing adenoma. It was a simple, benign goitre with no indication at all of a tendency to metastasize.

Be they derived from carcinomas, or from proliferating strumas, or from benign nodose goitres, thyroid metastases are known to elect certain characteristic locations. Usually they appear in the lungs, and in various bones[17, 18, 19, 20]. They have also been found in the heart, kidneys, liver, skin,[21] in the chorioid plexus, in the adrenal, and in the chorioid coat of the eye.[22] But never have any been described so far, in the omentum or on the peritoneal surface of abdominal viscera. That the altogether benign struma colli should have metastasized at all, was unlikely. That having metastasized, it should avoid its elected positions in the lungs, bones, heart, liver, etc., only to appear exclusively in a quite unprecedented location, the omentum, was even more unlikely. There was no evidence at all sufficient to support the omental thyroid nodules as adult metastases from any struma colli. The gland in the neck could not then, readily be invoked as their primary source.

Ectopic thyroid tissue was also found in the ovary. On surfaces made by section, there were areas in the ovary between its larger cysts which, even grossly, resembled thyroid tissue. Microscopically, these areas repeated the structure of any nodose colloid goitre, showing even similar degenerative changes. Krous' stain here too revealed the identity of the colloid in the ovarian thyroid follicles with the colloid in the struma colli, and that in the omental nodules. An iodine determination was not made because the small amount of ovarian material available was used up in the histologic study. But morphologically and tinctorially the tissue in the ovary was undeniably thyroid.

Thyroid tissue in the ovary has been described many times.[23] There may be only a little of it buried within the ovary. It may replace most of the ovarian substance. It may even do so entirely, so that in place of an ovary, there is found only a mass of thyroid tissue.[24] This may involve only one ovary or both.[25] Gottschalk[26] first described this tissue within the ovaries, but mistook it for a folliculoma. Kretschmar[27] recognized its identity with thyroid tissue, but assumed that it arose as a benign metastasizing adenoma of the neck.

Here, too, it was at once contested that goitres are not known to metastasize to the ovaries. The struma colli in these cases might not show the slightest invasive tendency. If metastatic nodules of a carcinoma or a struma proliferans or of a benign invading struma are not found in the ovaries, it is quite unlikely that the ovary should alter its warranted disposition to accept these nodules from a perfectly benign, non-invading goitre. Benign thyroid tissue might wander elsewhere, just as do the malignant thyroid tumors, but in the ovary its presence could also not readily be accounted for on a metastatic basis, from the neck.

Pick[28] then observed that often, along with the thyroid tissue, there was

also found in these ovaries, a variety of other structures such as bone, teeth, hair, cartilage, sebacious material, intestinal epithelium and nervous tissue. Calcium, cartilage and even bone may appear in degenerating thyroid tissue. But degenerative changes can certainly not account for the presence of the hair, teeth, nervous tissue, etc. in these tumors. The complexity and variability in association of these structures suggested an embryogenic disturbance, an embryonic displacement into the ovary of multipotent cells which might in later life proliferate in the direction of forming thyroid tissue. Pick therefore conceived the struma ovarii to be not a metastasizing adenoma, but part or the whole of a teratoma.

Teratomas occur frequently in the ovaries, and thyroid tissue is often encountered in them as incidental parts of their variegated structure. In twenty-one dermoids which Pick examined, he found thyroid tissue in six. In one hundred cases of ovarian dermoid, Koucky found thyroid tissue in 19 per cent. Teratomas are totipotent, but any structure may outgrow the others. The thyroid tissue may predominate. Morgen[30] suggested that if a patient has a dermoid cyst of the ovary containing thyroid tissue, it is perhaps the same endocrine disturbance which usually leads to the development of a nodose struma colli, which may also call forth in her a goiterous development of the dermoid, and produce the struma ovarii.

The thyroid tissue may predominate even to the exclusion of the other elements. In most cases, even if the ovary shows grossly only thyroid tissue, microscopic examination reveals the presence also of various teratoid elements.[31] Occasionally, however, even careful examination by serial section fails to reveal anything but thyroid tissue in the ovary. In my case, thyroid was the sole constituent of the tumor. No other dermoid elements could be found with it.* Manasse[34] reported a similar case. He too emphasized that the thyroid element of a teratoid tumor, may, by elective growth, drop all of its companion teratoid structures and appear alone.

Pseudo-mucinous cystadenomas are similarly developed by preponderant growth of the intestinal epithelium elements of an ovarian teratoma, as the struma ovarii develops from its thyroid elements. Struma ovarii and pseudo-mucinous cystadenomas are indeed not only similar in origin, but are rather similar in appearance. Bauer[35] in fact, while admitting that the so-called "struma ovarii" originated as one-sided developments of teratomas, contested that they were not thyroid at all, but only modified pseudo-mucinous cysts. The dermoid structures often found associated, he dismissed as purely accidental companions. Most investigators have firmly refuted this suggestion. Even Kaufmann, in whose laboratory Bauer worked, denied it.

Struma ovarii is really an embryogenic, ectopic thyroid tumor. Morphologically, it is not merely similar to, but is identical with thyroid tissue. The

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* Kovacs offers as a more correct term than "struma ovarii," that of "teratoma strumoides ovarii." Since most of these growths are not trigerminal, to be absolutely correct, we should speak of a "teratoid strumoid tumor of the ovary." For brevity and because of established usage, the term "struma ovarii" will be retained in this paper.

contents of its follicles do not give the staining reactions or the chemical reactions for pseudo-mucin, at all (Kafka,[36]). Chemically this content is, however, identical with the colloid of the thyroid gland. Iodine has been demonstrated from time to time within it. Most of these strumæ do not function, any more than do the muscle or nerve or intestinal or tooth structures which may accompany them in the teratoma. But even a vicarious thyroid function has been observed clinically in the cases of struma ovarii reported (Morgen,[30] Kovacs,[37] Moench[38, 39, 40]).*

Like thyroid tissue in the neck, struma ovarii may become malignant. Moench reported one case with adeno-carcinomatous transformation in the centre of an otherwise benign ovarian thyroid. Frankl reported another, but in neither had metastases occurred. Without becoming definitely malignant, struma ovarii may begin to proliferate and break through the capsule of the ovary. Polano[41] described such a case, but the struma had not extended beyond the surface of the ovary.

Just like the pseudo-mucinous cystadenoma, a strumoid tumor may extend to the surface of the ovaries and extend beyond them. It may creep along the peritoneal surfaces, and implant itself everywhere in the peritoneal cavity. Morgen observed such implantation metastases in the course of a double oöphorectomy for a case of bilateral ovarian struma. Both ovaries and a biopsy from one of the metastatic nodules revealed a papillary struma nodosa. He concluded that it is the papillary form of struma which is most likely to spread from the ovary by implantation. But even the non-papillary type may metastasize.

Werth[42] reported a case of simple, non-papillary, struma ovarii in which, scattered over the peritoneum, there were numerous small nodules of the same thyroid tissue. These implantation metastases were restricted to the pelvis minor. The case here reported conforms to the same type of simple struma nodosa colloides, but its metastases had gone even further. They had spread chiefly up into the greater omentum. Adhesions of the omentum to the old operative site had perhaps directed this spread. The implanted nodules continued to proliferate. They extended freely along the omental fat tissue and finally into the intestinal serosa. They multiplied until the omentum was thickly strewn with them.

SUMMARY AND CONCLUSIONS

A case is reported in which as purely incidental autopsy findings, thyroid nodules were observed scattered over the omentum and the peritoneal surface of the intestines. Thyroid tissue was also found in the ovary. The patient had a nodose goitre, but the omental nodules had apparently not arisen from a

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* Manasse suggested that when there is a question of thyroid function of a struma ovarii, the tissue be used for a Gudernatsch acceleration of metamorphosis test. In his own case the possibility occurred to him only after the tissues were fixed. This was likewise my experience. It is hoped that some future case of struma ovarii will be so tested.

benign metastasizing adenoma. Neither had the thyroid tissue in the ovary been so derived.

The struma ovarii had arisen from an embryonically displaced thyroid anlage. It had developed by selective overgrowth of the thyroid elements of a teratoid tumor of the ovary in much the same way that a pseudo-mucinous cystadenoma develops from the intestinal epithelium anlage of a teratoma ovarii. Like the latter tumor, it had been able to send extensive implantation metastases into the omentum and peritoneal linings. Like the pseudo-myxoma peritonei produced by a cystadenoma, the struma ovarii had yielded in this case a strumatosis peritonei.

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TUMORS OF THE WALL OF THE THORAX

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TUMORS arising from the thoracic wall are sufficiently uncommon so that the experience of any one individual with them is rather limited. For this reason it seems advisable to report cases of such tumors in order to place them on record, and thus make available the experience of many. In 1921, Hedblom[1] collected two hundred thirteen cases of tumor of the bony chest wall. These included the series of Parham[2] (1898) and of Lund[3] (1913), thirty-five cases from the literature and forty-eight cases from the records of the Mayo Clinic, most of which were Hedblom's own cases. In 1925, Heuer[4] collected twenty-two additional cases to which he added five of his own, making a grand total of two hundred thirty-eight cases reported.*

Since 1925, I have found reports of twenty more cases (fifteen in a report by Harrington[9]) to which I wish to add seven cases from the records of the Peiping Union Medical College Hospital, and one case from another Peiping Hospital. In addition, five cases of superficial tumor are reported, and three cases of intrathoracic tumor presenting through the thoracic wall.

In the reports in the literature, the origin of the tumors is not always clear, intrathoracic tumors and tumors of the ribs and vertebræ all being listed together. Another confusing feature in most reports is the inclusion in the groups of tumors of cases of cold abscess, osteitis, chondritis, and abnormally prominent rib.

The incidence, etiology, diagnosis and treatment of these tumors have been so well covered by Hedblom, Heuer, Harrington and others that there is no necessity to detail them again. A few points, however, are worthy of further mention. In the first place, the pathology of many of these tumors is not clear. The majority are sarcomas of one variety or another, chiefly chondrosarcomas, but many are unusual in nature, and have not been clearly classified. There is even greater confusion in the classification of the intrathoracic tumors and tumors arising in the lung. The relation of trauma to the development of these tumors is likewise not clear. Often the tumors seem to have occurred just at the site of a previous trauma, but in many other instances it is impossible to obtain a history of trauma. The diagnosis of the type of tumor before operation has often been quite difficult, as also the determination of the point of origin. Rapid growth and pain favor a diagnosis of malignancy.

Early and radical operative removal is clearly the treatment of choice, as it is generally conceded that partial removal followed by radiation is of

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* Heuer excluded two of Lund's cases because they were incompletely recorded.

very little value; but it must also be remembered that tumors which histologically appear benign may recur after an apparently complete excision. There is a marked difference of opinion among surgeons as to the advisability of using pressure anæsthesia during the operation—some using it routinely while others report no untoward effects from opening the pleura wide without pressure anæsthesia.

The cases here reported from the Peiping Union Medical College Hospital have been divided into several groups: (A) tumors arising from the deep structures of the thoracic wall and partly intrathoracic; (B) tumors arising from the more superficial structures of the thoracic wall, but on clinical examination found to be apparently fixed to the deep structures; (C) tumors arising within the thorax and presenting through the thoracic wall. Subcutaneous fibromas and lipomas have not been included, nor have several small chondromas of the ribs which caused no symptoms, and which were observed during routine physical examination.

Group A

Date	Age	Sex	Trauma	Right or Left	Diagnosis	Treatment	Result
1924	29	M	o	R	Osteo-sarcoma (fibro-sarcoma) of rib	None	Not known
1925	38	M	o	R	Tumor of D 7 vertebra	None	Not known
1926	18	M	o	R	Osteo-sarcoma of rib	None	Not known
1928	26	F	o	L	Osteoma of rib	Resection	Well 1 year
1929	51	M	o	L	Sarcoma of ribs	None	No change
1929 1930	23	M	±	R	Fibro-sarcoma thoracic wall	Resection	Recurrence 4 months. Resection
1928	47	M	o	St.	Tumor of sternum? Aneurysm	Application of radium	No change
1928*	31	M	o	R	Chondro-sarcoma rib	Resection	Died

* Not operated on at P.U.M.C. Surgical specimen sent for examination.

There are eight cases in group A, one being the surgical specimen from another hospital. Three of the eight cases were subjected to radical resection. Of these three, one patient died, one developed a recurrence which

Group B

Date	Age	Sex	Trauma	Right or Left	Diagnosis	Treatment	Result
1921	48	M	o	R	Round-cell sarcoma	Excision	Not known
1923	22	M	x	R	Sarcoma? Endothelioma?	Excision	Not known
1924	31	M	o	R	Mixed-cell sarcoma	X-ray treatment	Not known
1928	33	M	o	L	Fibro-sarcoma	Excision	Well 2 yrs.
1923	35	M	o	R	Sarcoma	None	Not known

was subsequently removed and the other has remained well for more than a year.

In group B there are five cases, three of which were operated upon, all apparently being cured.

Group C

Date	Age	Sex	Trauma	Right or Left	Diagnosis	Treatment	Result
1928	12	F	0		Mesothelioma ·	None	Died
1924	45	M	0		Mesothelioma	None	Died
1922	50	F	0		Carcinoma	None	Not known

In group C there are three cases, none of which was operated upon. Autopsy was performed in two instances.

A single case, possibly lymphosarcoma, is briefly mentioned.

The accompanying tables show the types of tumor, treatment, and results.

CASE REPORTS

Group A

CASE I.—A Chinese male, twenty-nine years of age, was admitted to the hospital December 4, 1924, complaining of a hard mass in the wall of the chest on the right side. The tumor was first noticed about nine months before as a hard, painless mass, beneath the skin, fixed to the deep tissues. A short time after this the patient began to cough a little and raised some sputum which occasionally showed a trace of blood. The tumor gradually increased in size, but remained painless. For two months before admission there had been a dragging pain in the left upper quadrant of the abdomen, not associated with any gastro-intestinal symptoms. There had been marked loss of weight and strength, particularly during the last few months. During this same time, the cough ceased. About one month before admission, a swelling was noticed in the left axilla.

The physical findings on admission showed a young Chinese male, rather pale and emaciated. There was a prominent tumor over the right portion of the thoracic wall about seven by fifteen centimetres in diameter, apparently fixed to the fifth, sixth, and seventh right ribs. The skin over it was normal and freely movable. The tumor itself was hard and lobulated. There was dullness over the right lung with increased tactile fremitus and diminished breath sounds. In the right axilla there were several large, hard glands. The blood Wassermann reaction was negative. The blood count showed four million red blood-cells with 57 per cent. hæmoglobin, and 11,400 white cells with a normal differential count. Röntgen-ray examination of the chest showed evidence of metastatic deposits in the right lung. The fifth, sixth and seventh ribs were obscured by the dense tumor. A clinical diagnosis of osteosarcoma of the ribs was made. An axillary gland was removed for study which showed that the tumor was composed of spindle cells with rounded nuclei and many mitotic figures. The pathologic diagnosis was fibrosarcoma.

No treatment was instituted. The patient was discharged December 13, 1924, unimproved. No follow-up report is available.

CASE II.—A Chinese male, thirty-eight years of age, was admitted to the hospital on the neurologic service June 15, 1925, complaining of inability to walk for fifteen months. About four years before, he had begun to have shooting pain around the

waist and chest. Two years later the pain became very severe and he had to go to bed, and, after about two weeks, numbness of the legs was noted. In May, 1924, the legs became completely paralyzed and sphincter disturbances occurred.

On examination the patient was seen to be well developed and moderately well nourished. There were all the signs of a transverse myelitis with paralysis of both lower extremities, and there was almost complete anæsthesia below the level of the umbilicus, with a narrow girdle of hyperæsthesia just above the umbilicus.

Over the right side of the back, close to the spine and at the level of the seventh rib, was found a hard, bulging mass the size of a fist, adherent to the deep tissues, the skin over it being free. There was no fluctuation, no pulsation, no signs of inflammation, and only slight tenderness on pressure. There was no scoliosis or kyphosis. Except for this mass, nothing striking was noted on physical examination.

Röntgen-ray examination on June 17, 1925, showed complete destruction of the body, laminæ, transverse processes and spinous process of the seventh thoracic vertebra,

FIG. 1—Case II. Tumor of seventh thoracic vertebra with compression of the cord.

FIG. 2.—Case III. Tumor of eleventh rib, right, with compression of the cord.

leaving but slight trace of débris between the sixth and eighth vertebræ. There was also complete destruction of the seventh rib on the right side from the head outward to the mid-scapular line. The sixth and eighth ribs appeared normal. The spine showed no kyphosis nor lateral deviation. The lungs showed no signs of metastases though there was some evidence of thickening of the pleura (Fig. 1).

The Wassermann reactions of both the blood and the spinal fluid were negative. Combined cistern and lumbar puncture demonstrated a complete block of the spinal canal. The spinal fluid showed six cells above the block and eight cells below. The blood findings were normal.

A careful search was made for evidences of a primary tumor elsewhere, but, as none could be found, a diagnosis of primary tumor of the seventh thoracic vertebra was made. The patient was discharged without treatment. The further course of his disease is not known as he could not be traced after discharge from the hospital.

CASE III.—A Chinese male, eighteen years of age, was admitted on the neurologic service of the hospital November 3, 1926, complaining of inability to walk and a lump on the back. He had apparently been well until three months before when he began to

notice numbness starting in the toes and extending by degrees up to the hips. The legs gradually became weaker and for two weeks there had been complete paralysis of both lower extremities and of the sphincters. At the same time that these symptoms developed he noticed a lump in the middle of his back which slowly increased in size, but without pain.. There was no history of injury.

On examination the patient was found to be well developed and nourished. He had the signs of a complete transverse myelitis at the level of the first lumbar segment, with paralysis and anæsthesia below the level of the hips. Over the right side of the back near the spine was a firm, rounded tumor, the size of a fist, apparently attached to the eight, ninth and tenth ribs. It was very firm, non-tender, and the skin over it was freely movable. There was no frank scoliosis or kyphosis.

Röntgenologic examination showed a dense shadow of a conglomerate mass, roughly spherical in shape and about nine centimetres in diameter, lying to the right of the vertebral column at the level of the eleventh rib. It appeared to lie in the thoracic wall and its density was greater than that of neighboring bone. This mass pressed against the right side of the bodies of the tenth, eleventh and twelfth thoracic vertebræ, and deformed them, particularly the eleventh. The spinal ends of the tenth, eleventh and twelfth ribs on the right side were more or less obscured. There was pathologic fracture of the tenth rib. The radiologist made a diagnosis of osteogenic, malignant tumor of the spinal end of the eleventh rib, right, with secondary involvement of the thoracic vertebræ. The lung fields seemed to be clear (Fig. 2).

The examination of the spinal fluid showed a yellowish fluid from the lumbar puncture with six cells, and 6.4 milligrams protein. There were signs of a complete block of the spinal canal. The Wassermann reaction and the Kahn test were negative. The blood examination showed slight anæmia. During his stay in the hospital, there was progressive increase in the patient's neurological signs, and he began to lose weight. Operation and radiation were thought to be inadvisable in this case and the patient was discharged without treatment. His course was not followed after he left the hospital.

CASE IV.—A Chinese woman, aged twenty-six, entered the hospital October 22, 1928, complaining of a large, firm mass in the left axillary region, of four years' duration. The tumor was first noticed as a small, hard nodule which apparently came on spontaneously and within a short time was said to have grown to the size of a walnut. During this time there was no pain. The patient could not give a very clear account of the rate of growth, but apparently it was rather slow until seven months before admission when there was rapid increase in size associated with some pain. There had been no fever or chill, no cough, and no loss of weight. There was slight disability in the left arm.

On examination, the patient was found to be well developed and nourished. A rounded mass could be seen protruding in the left anterior axillary line at the level of the second, third, and fourth ribs. On palpation this tumor was smooth, somewhat nodular and stony hard. The skin and subcutaneous tissues moved freely over the tumor, but the mass was firmly fixed, apparently to the bony structures of the thoracic wall.

The excursions of the wall of the chest during respiration seemed equal on the two sides. The tactile fremitus over the upper left lung, both front and back, was diminished, the percussion note was impaired, and the breath sounds decreased. Otherwise, nothing abnormal was found.

The urinalysis was negative. The blood examination showed normal findings. The Wassermann reaction and the Kahn test were both negative. The patient ran a slight fever up to 38° C. or slightly higher in the evenings, for which no cause could be found. The clinical diagnosis was osteoma or chondroma of the ribs.

Röntgen-ray examination gave very striking findings (Fig. 3). The right lung was clear. On the left side the entire lung field from the apex to the fifth rib anteriorly was occupied by a large mass of great density. Part of this mass lay outside the thoracic cage, but the major portion was within. The upper ribs were so obscured that the point of origin could not be determined. The tumor was lobulated, the surface somewhat granular, and in parts, the calcification was very irregular.

The patient was operated upon October 30, 1928, under intratracheal ether anæsthesia. A curved incision was made, and a skin-muscle flap raised and turned upward. The extrathoracic portion of the tumor was much larger than was anticipated, reaching up under the clavicle and high into the axilla. It was impossible to tell where it arose, but it was intimately adherent to and surrounded the first, second and third ribs. The pleural cavity was opened by dividing the second rib, and a small amount of
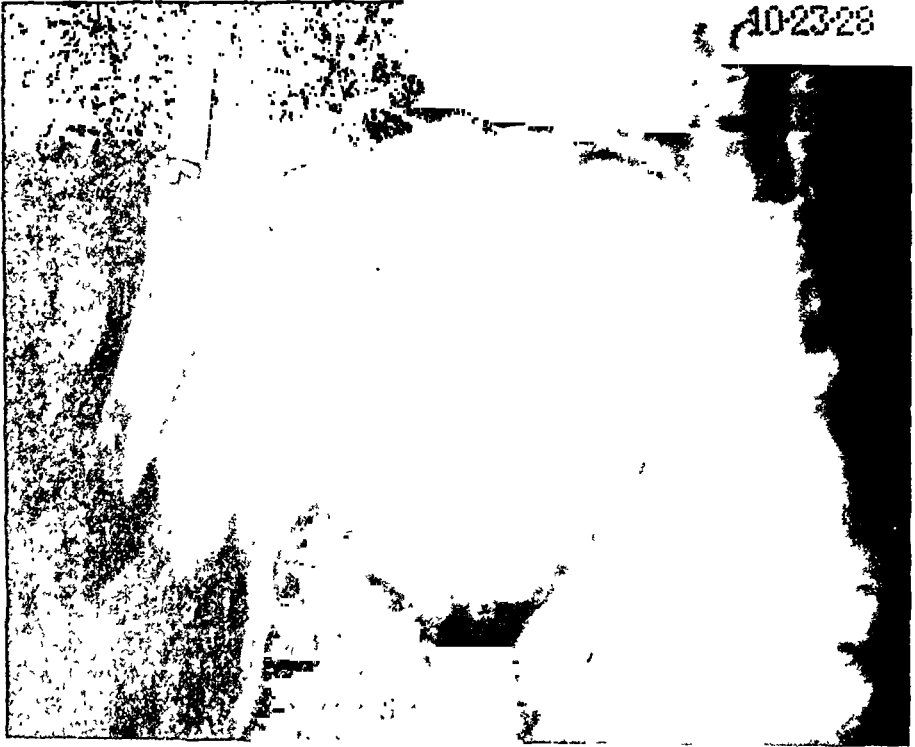
FIG. 3.—Case IV. Osteoma of second rib, left.

clear, yellowish fluid was obtained. The tumor was found to fill the entire upper half of the pleural cavity, reaching well up into the apex and nearly to the mediastinum. There were a few filmy adhesions between it and the lung. The tumor was removed by dividing the first, second and third ribs and the chest wall in front of and behind the tumor. Exposure was very difficult especially in the axilla and around the first rib, but fortunately neither the axillary structures nor the subclavian vessels were injured. There was some shock just as the tumor was removed. Where the tumor came in contact with the lung, there were two firm, oval, calcified nodules about two by two by five millimetres apparently in the visceral pleura. These were not disturbed. In removing the tumor, about three and one-half centimetres of the first rib and about fifteen centimetres each of the second and third ribs were removed. The defect in the chest wall was covered with the skin-muscle flap which was sutured in layers with interrupted silk. The lung was expanded just before the final suture was tied. A pressure dressing was applied. Three hundred and fifty cubic centimetres of whole blood was given before the patient was returned to the ward.

For several days the patient had moderate fever, which then subsided. There was some effusion of fluid into the pleural cavity, which was aspirated several times, from 200 to 400 cubic centimetres being obtained each time. The chest was kept well strapped for several weeks and then a chest binder fastened with straps and buckles was used. The lung gradually expanded. The patient was discharged November 29, 1928. Her only disability was pain in the left arm and shoulder, and inability to raise the arm well. She was seen in December, 1928, and in January and March, 1929 (Fig. 4). The last report from the patient in November, 1929, stated that she was still unable to lift the arm well.

The specimen consisted of a large, nodulated, very hard tumor mass sixteen by fourteen and one-half by twelve and one-half centimetres. It weighed 1,230 grams and had a specific gravity of 1.54. On the surface were many nodules, and three segments

FIG. 4.—Case IV. Osteoma of rib, three months after operation.
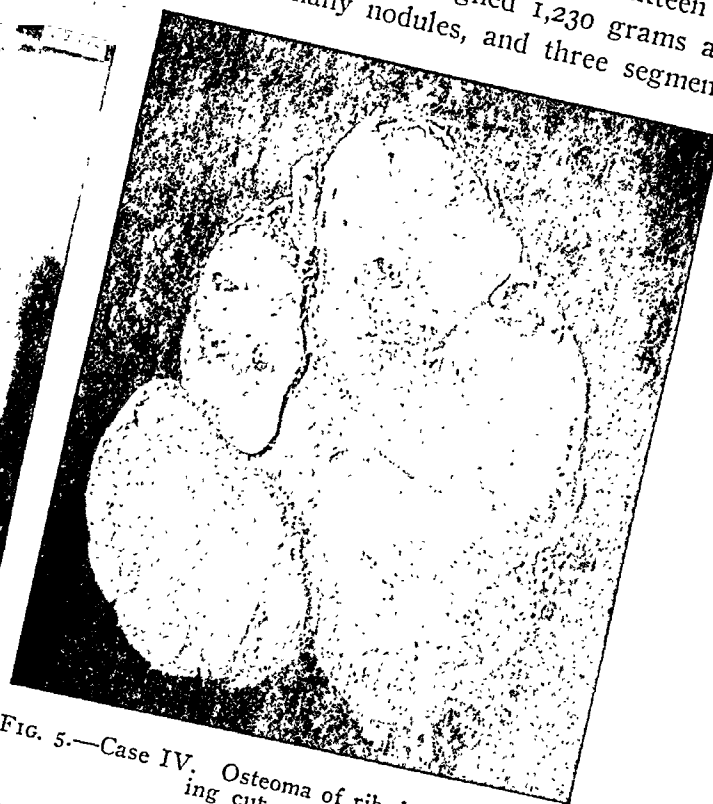
FIG. 5.—Case IV. Osteoma of rib, bisected, showing cut surface.

of ribs were firmly held. The tumor was sawed in two (Fig. 5) with some difficulty because it was so hard. The cut surface showed that the tumor was made up of nodules of hard, osteoid tissue joined together by fibrous tissue. The first and third ribs were encircled by the hard tissue while actually not attached to it, but the second rib could not be seen in the cut section, the tumor apparently having arisen from it, and completely replaced it.

The microscopic examination showed that the tumor was composed of bone trabeculæ running in all directions, the structure resembling that of cortical bone. The fibrous stroma was made up of rather dense connective tissue with poorly straining, hyaline areas, and with numbers of stellate cells, some of which contained two nuclei. No mitotic figures were seen. The capsule was sharply marked and was composed of dense, partly hyalinized connective tissue. The pathologic diagnosis was osteoma (exostosis fibrosa; spongy type).

CASE V.—A Chinese farmer, fifty-one years of age, was admitted to the hospital September 20, 1929. Nine months before, he had accidentally noticed a hard tumor, the size of a walnut, on the left side of the chest, above and to the left of the nipple. One month later he developed shooting pains in the chest and down the arm. About the same time there developed cough with blood-streaked sputum, and the tumor began

to increase rapidly in size. The tumor was firmly attached to the thoracic wall from the beginning, but the skin was freely movable over it.

At the time of admission, the patient was rather emaciated and anæmic, and apparently was having continuous, rather severe pain. There was a prominent tumor, the size of a fist, above and to the left of the left nipple. The skin over it was normal and freely movable. The tumor itself was irregular, hard, and fixed firmly, apparently to the bony structures of the chest wall.

On percussion there was dullness over the entire left lung field with bronchial breathing, but no râles were heard. There was moderate cough with a small amount of blood-streaked sputum.

The blood showed three million red cells with 65 per cent. hæmoglobin, and 6,800 white cells with a relative lymphocytosis. The Wassermann reaction and the Kahn test were both negative. The Röntgen-ray examination demonstrated destruction of the anterior portion of the third, fourth, fifth and sixth ribs, and a rather dense, homogeneous shadow over almost the entire left lung field which was taken to indicate pleural and probably pulmonary involvement by tumor. A diagnosis of sarcoma of the thoracic wall was made, and the patient was discharged without treatment.

CASE VI.—A Chinese carpenter, aged twenty-three, was first admitted to the hospital May 4, 1929, because of a tumor of the right lower chest of one year's duration. It was first noticed immediately after a fight and was firm, slightly painful, and the size of a hen's egg. It increased gradually in size. No other symptoms were noted. There was no cough, and no loss of weight. The tumor was firm, round, and fixed to the thoracic wall, ten by fourteen centimetres in size. The skin over it was freely movable but showed some enlarged veins (Fig 6). The Röntgen-ray examination showed irregularity of the dome of the right diaphragm, but no evidence of direct connection of the tumor with either the ribs or diaphragm. During inspiration, it was noted by fluoroscopic examination that the tumor moved up with the thoracic wall while the diaphragm moved downward. The blood examination was normal. The Wassermann reaction and the Kahn test were both negative.

The patient was operated upon May 8, 1929, under intratracheal ether anæsthesia. An elliptical incision was made parallel to the ribs. The tumor was found to be somewhat dumb-bell-shaped, extending to the pleural cavity, pressing on the diaphragm and attached to it. In order to remove it, it was necessary to resect segments of the seventh, eighth and ninth ribs, together with a considerable area of pleura. The pleura was closed, the diaphragm was sutured to the intercostal muscles, and the whole was covered with a skin-muscle flap. After operation the patient had considerable temperature reaction and signs of atelectasis of the middle and lower lobes of the right lung with some pleural fluid. The temperature soon came down to normal, however, and the patient was discharged May 20, 1929.

The tumor was roughly dumb-bell-shaped, the outer portion measuring fifteen by thirteen by nine centimetres, the inner nine by seven by four and one-half centimetres. It was firm, consisting of coarse bundles of grayish-yellow tissue, and contained a few cysts. It had apparently arisen from the intercostal tissues, and at one area showed invasion of the cartilaginous portion of a rib. Microscopically, it presented the typical appearance of a fibrosarcoma.

September 4, 1929, the patient returned with a recurrence the size of a hen's egg, but he refused to enter the hospital.

December 7, 1929, he again returned, with the tumor now the size of a fetal head, ulcerated at the surface (Fig. 7). He was re-admitted to the hospital December 11, 1929, in fairly good general condition. The tumor was painless. It projected forward from the thoracic wall for six centimetres, and the circumference at the base was thirty-six centimetres. It was rather soft, seemed fluctuant, and adherent to the deep structures. The skin over the tumor was ulcerated.

The röntgenologic examination of the chest showed nothing abnormal except the resected ends of the seventh and eighth ribs. The blood examination gave normal findings.

The second operation was made December 17, 1929, under ether anæsthesia. After circumscribing the base of the tumor, a membrane which was thought to be the thickened pleura was opened, but it gave entrance to the peritoneal cavity, the diaphragm being adherent to the ribs above the tumor. The tumor was then removed by excising the entire thickness of the abdominal wall, portions of the cartilaginous ends of the ribs and a bit of the sternum. The pleural cavity was not opened. This left a wide defect in the epigastric region. By undermining the skin on both sides and making relaxation incisions in the mid-axillary line on each side, it was possible to approximate the skin and subcutaneous tissues, but there remained a defect in the peritoneum, muscle and fascia, about the size of a hand. This was covered with a layer of fascia lata from the right thigh which was sutured with interrupted silk to the peritoneum

FIG. 6.—Case VI. Fibro-sarcoma of thoracic wall.   FIG. 7.—Case VI. Recurrent fibro-sarcoma.

and fascia on both sides. The skin flaps were then closed over the fascial transplant, and the relaxation wounds were covered with Thiersch grafts. Except for signs of atelectasis of the right middle lung and the lobes, and of possibly some bronchopneumonia, the patient made an uneventful recovery, and was discharged January 10, 1930. The tumor measured eighteen by twelve by ten centimetres. It presented much the same appearance as the original tumor except that it was more cellular and mitoses were more frequent. A diagnosis of fibrosarcoma was made.

The patient has not returned for examination. According to the patient's wife he was entirely well in May, 1930, and too busy working to have time to come to the hospital for examination.

CASE VII.—The following report is of a case in which the diagnosis was never clearly established between a vascular tumor of the sternum and an aneurism. The patient was a Chinese farmer, forty-seven years of age, admitted to the hospital March 8, 1928. He complained of severe pain in the chest and a tumor over the sternum. The pain began three years before, was severe and cutting in character, and the patient had become a morphine addict because of it. Ten months before admission

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a tumor was noticed in the centre of the sternum. Within six months this tumor grew to the size of a hen's egg.

The tumor was seen as a prominent, bulging, purplish, pulsating mass, over or through the mid-point of the sternum at the level of the nipples and opposite the third, fourth and fifth ribs. Normal heart sounds could be heard in it but there was no bruit, shock or thrill. The heart was normal in size. The Wassermann reaction was strongly positive, but there were no other signs of tertiary syphilis. The röntgenologic examination was rather in favor of aneurism. There was, however, considerable difference of opinion amongst different observers as to whether it was a tumor or an aneurism. A radium pack was applied but there was no change in the tumor. The patient was discharged unimproved March 27, 1928 He did not respond to the follow-up letters sent two months and six months later.

CASE VIII.—This patient was operated upon at another hospital in Peiping, but the surgical specimen was brought to us for examination.
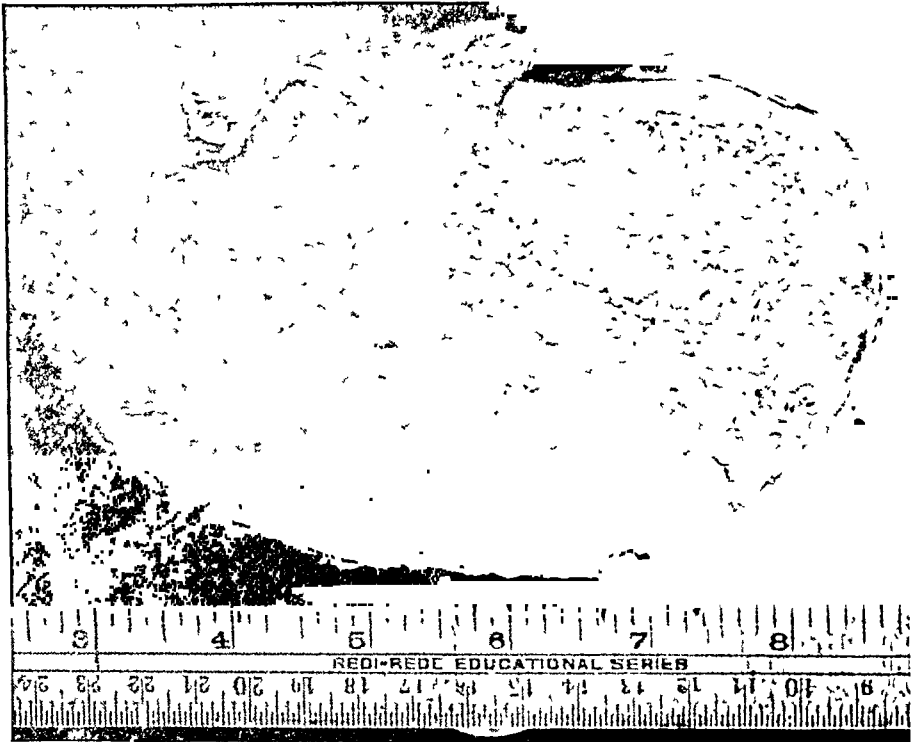
FIG 8 —Case VIII Chondro sarcoma of ribs   Cut surface of surgical specimen.

The patient was a Chinese man, about twenty-five years of age, who had a large, painless swelling of the right lower chest of several years' duration. The tumor was the size of a large grapefruit. The rontgenologic examination showed that the tumor apparently arose from the seventh rib and a portion of it presented within the pleural cavity. It was apparently an osteochondroma (Fig. 8).

The patient was operated upon November 8, 1928, under intratracheal ether anæsthesia. In order to get exposure and remove the tumor it was necessary to resect three ribs and a considerable area of pleura. The defect was closed with the skin-muscle flap. The patient died rather suddenly about five hours after operation. The pathologic report was chondrosarcoma.

Group B

Thoracic tumors arising in the subcutaneous tissues.—In addition to the foregoing group of tumors which arose from the deep structures of the

thoracic wall, there have been seen in the Peiping Union Medical College Hospital other patients with tumors arising in the subcutaneous tissues. Excluding cases of lipoma, skin tumors, and tumors arising in the lymphatic glands, the following cases were seen and are here briefly reported. The clinical examination in some of these cases showed that the tumor was tightly adherent to the deep structures of the thoracic wall, but in all instances either the history or the operative findings indicated that the primary origin was superficial to these structures.

CASE IX.—A Chinese 'rickshaman, forty-eight years of age, was admitted to the hospital August 29, 1921, with the complaint of a tumor on the right side of the chest. This tumor first appeared in 1916 and ulcerated through the skin about six months after it was noticed. In April, 1918, it was excised, the specimen consisting of a flat mass about fourteen by eight by six centimetres with ulceration of the skin. Microscopic examination showed that it consisted of large and small round cells and spindle cells and a diagnosis of large round-cell sarcoma was made.

A small recurrence was noted in the out-patient department in January, 1920, and excision was recommended, but the patient did not return for admission. In August, 1921, however, he came back again and was admitted to the hospital. At this time the tumor was situated in the right mid-clavicular line just below the clavicle, and above the scar of the previous operation. It was about the size of a large apple, four by three by two and one-half inches, adherent to the skin, but movable over the deeper structures. It was rounded, soft, semi-fluctuant, non-tender on pressure, and painless. The axillary glands were not palpably enlarged. The lungs were clear except for a few moist rales. No Röntgen-ray examination was made.

The tumor was excised on August 31, 1921, together with a large area of skin, the pectoral muscles and fascia, and the axillary contents. The axillary glands showed no gross or microscopic evidence of metastases. The tumor itself was made up of large round and oval cells with a few giant cells. A diagnosis of sarcoma was made. The late end-result is not known.

CASE X.—A Chinese soldier, twenty-two years of age, was admitted to the hospital March 30, 1923, because of a recurrent tumor in the region of the right breast. At the age of ten years the patient received an injury to this area followed by ecchymosis of the skin. About two years later a small tumor was noticed in this same region. The lump was painless and grew slowly until it reached a size of two and one-half inches in diameter in about four years. At that time (1917) it was removed at a missionary hospital in Shantung Province—the left breast being removed with the tumor. The incision was sutured and healed in eight days. In 1922 a recurrence was noted about the size of a finger tip, which caused no symptoms and enlarged very gradually.

Examination revealed a young Chinese male, normal in appearance except for the presence of a bulging tumor over the left thoracic region, six by five by two and one-half centimetres in size, lying a little to the left of the mid-line, at the level of the right nipple. The left nipple had been removed and a long, transverse scar passed across the tumor. There were dilated blood-vessels visible in the skin over the tumor, and the skin was discolored a little. Near the apex of the tumor the skin was adherent to it, but the mass was freely movable over the deep structures of the chest. It was oval and very firm. The general physical examination was negative. The blood and urine were normal. No Röntgen-ray examination is recorded and there is no note of a Wassermann reaction.

A local resection of the tumor was done April 2, 1923, under general anæsthesia. A wide removal of skin was done. The tumor lay in the subcutaneous tissues and no

muscle or bone was removed. The denuded area was covered with Thiersch grafts which healed well, and the patient was discharged April 21, 1923.

The tumor was found to be encapsulated, and looked grossly like a fibroma. The microscopic examination showed that the tumor was made up of bundles of spindle cells which varied considerably in size and shape. Throughout the tumor were blood spaces apparently lined only by tumor cells. A diagnosis of sarcoma was made but endothelioma was also considered as a possibility. The late end-result is not known as the patient could not be traced after leaving the hospital.

CASE XI.—A Chinese soldier, thirty-one years of age, was admitted to the hospital February 26, 1924, because of a large tumor attached to the right side of his chest. The tumor was first noticed about a year before admission, at which time it consisted of a small firm nodule over the third right costal arch which seemed to be attached to the skin and was movable with it over the deep tissues. There was no history of
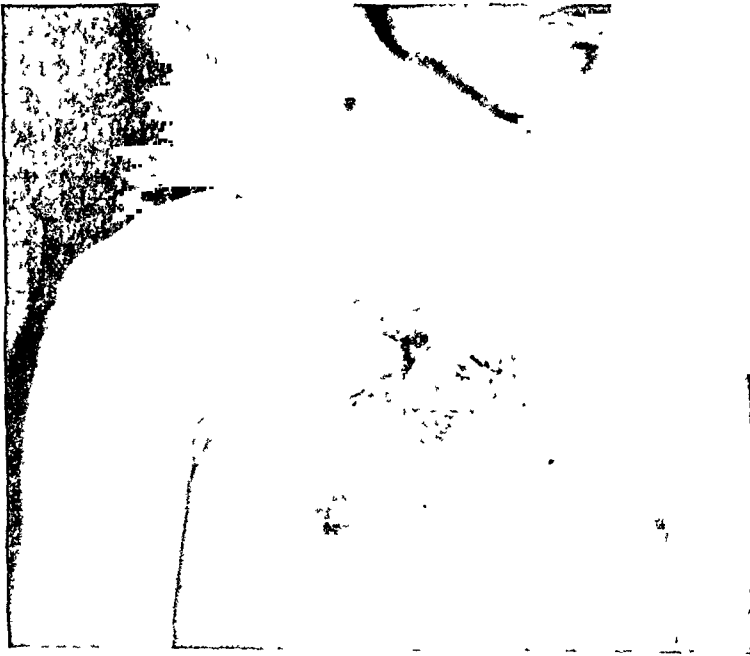
FIG. 9.—Case XI. Spindle and round-cell sarcoma.

injury. At first the tumor was painless, but as it grew it became very painful, the pain being constant and throbbing and so severe that the patient was unable to sleep. The growth was very rapid. About six months after the onset, the tumor was excised in an army hospital. The wound healed in seven days, but the tumor recurred within one month, grew more rapidly than before and was extremely painful. Within three months it had regained its previous size and was excised a second time. It recurred for the second time within a few weeks and was about ten centimetres in diameter when the patient was admitted to the hospital. The patient had some cough but no hemoptysis, and there had been no loss of weight or strength.

On examination the patient was found to be moderately well nourished but slightly anæmic. The prominent tumor projected from the right anterior aspect of the thoracic wall directly above the nipple (Fig. 9). It was about sixteen by fourteen centimetres in diameter, irregularly nodular and adherent to the skin at the old scar of the previous operations. It was firm in consistency throughout, and so firmly fixed to the thoracic wall as to be immovable on the deeper structures. The liver was just palpable. The clinical examination of the lungs was negative. No enlarged glands were felt. The röntgenologic examination showed no changes in the lungs,

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pleura or ribs. The blood examination showed a slight anæmia with a normal white blood count. The Wassermann reaction of the blood was negative. A portion of the tumor was removed for microscopic examination which showed that it was composed of large round cells in solid masses which were invading striated muscle. A few spindle cells were present. A diagnosis of mixed-cell sarcoma was made.

The tumor was regarded as inoperable. A superficial Röntgen-ray treatment was given February 29, 1924. The patient was discharged from the hospital March 1, 1924, but returned for further Röntgen-ray treatments on April 11, and again on April 26. These had no effect on the growth of the tumor. The general condition of the patient remained fairly good. During subsequent fighting the patient's battalion was lost and the few survivors could not be traced.

CASE XII.—A Chinese farmer, aged thirty-three, was admitted to the hospital June 6, 1928, because of a large, ulcerating tumor in the left mammary region. The tumor

FIG. 10.—Case XII. Fibro-sarcoma of chest wall.

FIG. 11.—Case XIII. Sarcoma of right axillary region.

had been first noticed sixteen years before as a small mass, the size of a walnut, above the left breast. In eight or nine years it grew to the size of a hen's egg, and continued to grow slowly, causing no symptoms, until the winter of 1926, when it began to increase rapidly in size. By July, 1927, it had attained the size of a small melon. The patient then began to notice weakness and exhaustion, anorexia and loss of weight. In February, 1928, the skin broke open and a deep ulcer with foul discharge appeared. There was no pain at any time.

Examination showed a young Chinese man moderately emaciated with a huge ulcerating tumor hanging from the left wall of the chest (Fig. 10). There were large dilated veins visible in the skin. The mass was particularly movable over the thoracic wall. The Röntgen-ray examination showed no evidence of destruction of the bones of the thoracic cage or any pulmonary metastases though the tumor itself obscured the left portion of the lung field so that an accurate estimate could not be made. The

blood examination showed three million red cells with 37 per cent. hæmoglobin, and a normal white cell count.

Under ether anæsthesia, the tumor, with a wide area of skin and a portion of the pectoral muscle, was excised with the cautery June 8, 1928. A portion of the wound was left open as there was insufficient skin to close it, and it was later covered with small deep grafts. The patient was discharged July 2, 1928. Microscopic examination showed typical fibrosarcoma.

According to a report made by the patient's relatives May 7, 1930, he was entirely well at that time.

CASE XIII.—A Chinese male, thirty-five years of age, was admitted to the hospital May 8, 1923, because of a mass over the right side of the chest and axillary region of six months' duration. The tumor was first discovered accidentally in the region of the right breast and was thought to be attached to the skin. It was hard and non-tender. A hard lump was next noted in the axilla and both grew until they coalesced to form a single, large, moderately firm, very slightly movable mass (Fig 11). Associated with this there developed first weakness, then numbness, and finally complete paralysis of the right arm. At the time of admission the tumor consisted of a large, rounded mass filling the right axilla, pushing the arm out from the side, and extending downward over the wall of the chest. No enlarged lymph-nodes were palpable. The blood examination and Wassermann reaction were negative. The röntgenologic examination of the chest showed evidence of metastases to the lungs, but no enlarged mediastinal glands. In view of these findings a diagnosis of sarcoma of the thoracic wall was made, as a tumor arising from the lymph-glands seemed unlikely. No treatment was attempted. The course after leaving the hospital is not known.

Group C

Secondary growths.—In addition to these tumors of the wall of the chest, which were all considered to be primary, there are in the Peiping Union Medical College Hospital records of another group of cases which are thought to be secondary. These will be very briefly reviewed.

CASE XIV.—An American girl, twelve years of age, was admitted to the hospital December 6, 1928, because of pallor, loss of weight, and some weakness of the left leg. The clinical and Röntgen-ray examinations were suggestive of pleural thickening and effusion into the left pleural cavity, presumably tuberculous in nature, and of early tuberculosis of the left hip-joint. Subsequent findings indicated that there was a malignant tumor of the pleura with multiple metastases to the bones of the pelvis, both femora, and the vertebral bodies. There was also direct extension through the wall of the chest, a rounded mass, apparently attached to the left fifth rib, being palpable for several months before death, which occurred February 8, 1929.

CASE XV.—A Russian male, forty-five years of age, was admitted January 24, 1924, because of pain in the left chest, dyspnœa, and cough with sputum for nine months. In addition to flatness over the left side of the chest, there was present a conical tumor ten by seven centimetres at the postero-lateral aspect of the chest, a little below the angle of the scapula. This was firm, immovable, and apparently attached to the thoracic wall. Autopsy showed a tumor involving practically the entire left lung with extension to the pleura, ribs, and intercostal muscles. The tumor proved to be a mesothelioma. There was also extensive tuberculosis of both lungs.

CASE XVI.—A Chinese woman, fifty years of age, was first admitted to the hospital December 6, 1922, with vague abdominal pains which were diagnosed as being due to chronic gastritis. She was discharged January 8, 1923. She was re-admitted March 3, 1923, because of pain in the back and left shoulder. On this occasion there was a hydrothorax on the left, with enlarged glands in the left supraclavicular region. One

of these glands was removed, and microscopic examination showed carcinoma. The primary tumor could not be definitely located. The patient left the hospital April 20, 1923.

She returned to the hospital again October 30, 1923, this time with a tumor the size of an apple in the posterior axillary region of the left side, adherent to the deep structures, and nodules in the left fourth rib anteriorly. Röntgen-ray examination showed partial destruction of the left scapula, the left humerus, and the left seventh and eighth ribs, apparently due to metastastic carcinoma. The primary tumor was never located.

Cases collected from the literature 1929–1930

Author	Date	Age	Sex	Right or Left	Origin	Pathology	Treatment	Result
1. Mole [5]	1928	37	M	R	Ribs	Chondroma	Excision	Well—immediately
2. Lyle [6]	1928	20	F	R	Soft tissues	Hemangioma	Excision	Well—immediately
3. Hess [7]	1926	49	F	L	Ribs?	Fibro-lipoma	Excision	Well—immediately
4. Lockwood [8]	1928	50	F	R	Ribs	Chondro-sarcoma	Partial excision, radiation	Recurrence (two times)
5. Lockwood [8]	1928	26	M	R	Soft tissues?	Round-cell sarcoma	Partial excision, radiation	Unimproved
6. Harrington [9]	1927	18	M	L	Ribs	Osteo-fibro-sarcoma	Radical operation	Well 17 months
7. Harrington [9]	1927	13	F	L	Ribs	Osteo-sarcoma	Partial resection, radiation	Recurrence, Death
8. Harrington [9]	1927	15	F	R	Ribs and pleura	Endothelioma	Partial resection, radiation	Recurrence, Death
9. Harrington [9]	1927	3	F	R	Ribs	Osteo-genetic sarcoma	Partial resection, radiation	Death 9 months
10. Harrington [9]	1927	58	M	R	Ribs	Chondro-sarcoma	Resection, Radium	Well 8 months
11. Harrington [9]	1927	54	M	R	Ribs	Chondro-sarcoma	Resection, Radium	Well 18 months
12. Harrington [9]	1927	42	M	L	Ribs?	Lympho-sarcoma	Resection, Radium	Well 11 months
13. Harrington [9]	1927	45	M	L	?	Fibro-sarcoma	Removal, radium	Well 11 months
14. Harrington [9]	1927	46	F	L	Secondary to breast tumor	Lympho-sarcoma	Radical resection, radium	Well 14 months
15. Harrington [9]	1927	29	F	R	Ribs	Fibro-myxo-sarcoma	Radical resection, radium	Well 3 months
16. Harrington [9]	1927	44	F	R	Rib	Old healed fracture?	Resection	Well
17. Harrington [9]	1927	57	F	R	?	Tuberculous abscess	Drained	Well
18. Harrington [9]	1927	29	F	R	Rib	Exostosis	Removal	Well
19. Harrington [9]	1927	37	F	L	Rib	Achondrosis of cartilage	Removal	Well
20. Harrington [9]	1927	32	F	R	Rib	Areas of necrosis of cartilage	Removal	Well

A chart showing the cases collected from the literature is appended. I am indebted to Dr. C. K. Hsieh, of the Department of Röntgenology, for his interpretation of the Röntgen-ray films and for his helpful suggestions.

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SARCOMA OF THE BREAST

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THE pure connective tissue type of malignancy of the breast is rare. In this paper, we record (Table I), the eleven cases of sarcoma of the breast that have occurred at the Charity Hospital of Louisiana during the last twenty-five years, and briefly review the literature relative to the subject.

Incidence.—Williams, in 1892, reported that in a series of 2,422 breast neoplasms, 3.5 per cent. were sarcomatous. In a group of 12,823 primary tumors, he found 1,081 sarcomas an incidence of 0.17 per cent. of all recorded tumors. Winslow, in 1911, reviewed a series of 100 cases of tumors of the breast occurring in the University Hospital of Baltimore and found that sixty-three were carcinomas, three sarcomas, twenty fibro-adenomas, one a pericanalicular myzoma, five cystic fibro-adenomas, two galactoceles, three tuberculous mastitis and three abscesses. Thus, in this series, 63 per cent. of the cases were carcinomas and 3 per cent. sarcomas. In 1921, the same author reviewed 102 cases of breast tumors seen in the same hospital in the preceding three years, and of these 59.8 per cent. were carcinomas and 2.94 per cent. sarcomas. Deaver, in 1917, cited 838 cases of sarcoma of the breast in the literature, and stated that this figure is probably somewhat incorrect due to difficulties afforded by careless and faulty classifications. He further states that the fifteen cases of breast sarcoma which came to operation at the Lankenau Hospital represented 2 per cent. of the total of breast tumors observed at that institution in a period of sixteen years. Por- ter, in 1920, published a study of seventy-seven breast tumors which he had observed personally. Forty-nine were malignant, one being a sarcoma. Ewing quotes Rodman to the effect that in a series of 5000 cases of breast tumors, 2.78 per cent. are sarcomatous. Fischer, in a series of 300 breast specimens received at the Pathological Institute at Rostock, from April, 1922, to May, 1925, found 152 carcinomas and one sarcoma. In our studies of the literature relative to sarcomatous tumors of the breast, we find the last detailed review to be that of Geist and Wilensky, in 1915. They reported twenty-two cases, and, including these, collected 435 breast sarcomas from the literature. We have been able to find fifty-seven cases reported since this review, and add the eleven cases which have been recorded at Charity Hospital during the last twenty-five years. We have not included cases where the author was not entirely certain of the nature of the tumor, nor of the fact that it was not a secondary growth or part of a generalized sarcomatosis. We found several such instances recorded under

TABLE I

Cases of sarcoma of breast occurring at Charity Hospital, New Orleans

1904–1929

Hospital No.	Age	Sex	Location and known duration of tumor	Treatment	Pathological type	Metastases and recurrences	Comments
C.H. 102–153	42	F.	Right. Several months.	Radical amputation	Round-cell	Axillary glands not enlarged	Made good post-operative recovery.
C.H. 154–153A	30	F.	Right. Fifteen years with rapid growth for last few months.	Radical amputation	Fibro-myxo-sarcoma	Enlarged axillary glands	Good post-operative recovery. Noteworthy for long duration.
C.H. 273–153A	30	F.	Left. Fourteen months.	Radical amputation	Cysto-sarcoma	Enlarged axillary glands	Post-operative recovery.
C.H. 232–153A	75	F.	Left. Eight years with rapid growth in last year.	Mammectomy	Fibro-sarcoma		Post-operative recovery.
C.H. 206–153A	23	M.	Right. Six months.	Mammectomy	Oat-cell sarcoma		Tumor dates to trauma six months previously; hit in the breast with doorknob, at which time swelling and inflammation with pus formation occurred.
C.H. 298–153B	59	F.	Left. Several months.	Mammectomy	Mixed-cell sarcoma	Enlarged axillary glands	Post-operative recovery.
C.H. 418–153C	55	F.	Right. Eight months.	Radical amputation	Sarcoma	Enlarged axillary glands	Post-operative recovery.
C.H. 542–153E	49	F.	Left. Two years.	Mammectomy	Fibro-sarcoma		Post-operative recovery.
C.H. 522–153E	46	F.	Right. Nine years.	Mammectomy	Chondro-sarcoma		Post-operative recovery.
C.H.	37	F.	Right. Thirteen years with more rapid growth in last year.	Radical amputation	Fibro-myxo-sarcoma		Post-operative recovery.
C H. 17281	39	F.	Left. Three months.	Radical amputation	Lympho-sarcoma	No evidence of metastasis	Good post-operative recovery.

the title of sarcoma of the breast. Thus we bring the number of recorded cases of authentic mammary sarcoma to 503 cases. Our search reveals, further, that during the last twenty-five years, 1035 cases of mammary carcinoma have occurred at Charity Hospital and during the same period there have been eleven authenticated cases of mammary sarcoma, making a total of 1046 breast malignancies, 0.1 per cent. of which were sarcomatous.

Etiology.—As with other types of malignancy, we are not able to establish any definite etiology for breast sarcomas. However, it is a well-recognized clinical fact that the existence of benign tumors of the breast may be looked upon as etiologically significant in the production of malignancy. While secondary malignant changes in such benign growths are usually of a carcinomatous nature, they may naturally occur in the connective tissue elements of the organ with production of a sarcomatous tumor. Consensus of opinion, as expressed in the reports which we have studied and as early pointed out by Labbe and Coyne, ascribes such "malignant metamorphosis" within a preëxisting fibroma or adeno-fibroma as the most important factor in the production of mammary sarcoma. Ribbert, Wilms, Burkard and Letulle stress the etiological importance of congenital anlage displacements and snipped-off fetal parts.

In the vast majority of cases the patients give a history of a symptomless, stationary tumor of many years' duration (forty years in a case reported by Sutton), which suddenly takes on rapid growth. From our study we are in agreement with the opinion of numerous authors that trauma is not a very important etiological factor in the production of mammary sarcoma, although in a few instances it must be considered, as for example, in Case V of our series.

Age Distribution.—Regarding age, Flynn says that "sarcoma of the breast differs from sarcoma of other regions in that it occurs most often between the ages of forty and sixty." Bindi states that "sarcoma of the breast usually develops in young women, being less often seen in children, and rarely at an advanced age." Finsterer (quoted by Speese), notes that the average age when sarcoma of the breast develops in men is 45.6 years, being practically ten years earlier than the average age of development of mammary carcinoma in the same sex. Greenough and Simmons find that mammary sarcoma occurs at a period later in life than the periductal fibroma. With this latter, the average age of occurrence according to their statistics was 28.8 years, while the average age of occurrence of the frank sarcoma was forty-nine years. In the series of cases from the Charity Hospital, we find twenty-three to be the youngest age, seventy-five years the oldest, with an average age incidence of 44.15 years.

Naturally, mammary sarcoma, as with all forms of breast pathology, is overwhelmingly more abundant in the female than in the male. In the fifty-seven cases of this tumor which we have collected from the literature since 1915, four cases occurred in males. In the series of eleven cases which we report from Charity Hospital, one was in a male. Many authors

state that pregnancy and lactation seem to have no important relationship to the origin of these tumors. If such be the case, it would then seem justifiable to attribute the high female sex incidence to the fact that benign breast tumors are so much more frequent in the female.

Pathology.—It is impossible to briefly state even the salient facts concerning the pathologic anatomy of the group of tumors classed as mammary sarcoma. The reason for this is evident when we consider the occurrence in the breast of teratoid growths and of mixed tumors, such as adeno-fibromas and adeno-sarcomas and the so-called pseudo-sarcomas. Excluding such growths, the formidably complex group dwindles to a comparative few, well-defined tumor types. As Ewing points out, such a disintegration of the group is most desirable. Still, the situation remains much the same as it was in 1894, when, because of the absence of required data and because of the form in which the little available data was present, Williams found it impossible to write a complete review of pure sarcoma of the breast.

From our personal experience and after critically reviewing and considering the pathology in the cases we have studied, we feel that an all-inclusive classification, however desirable, cannot be arrived at, and believe it best at present to limit the group to the pure sarcomas, represented by such rather distinct types as spindle-celled, round-celled, and polymorpho-celled growths—and even of these only the pure spindle-cell tumors approximate a well-defined type—and the adeno-sarcomas.

The adeno-sarcomas, even though a rather specific form of mixed tumor, are of extreme importance etiologically in considering the group of mammary sarcomas, as it is entirely probable, as Delbet first suggested, and as is now believed by many authors, that they have the same origin as most pure sarcomas, at least the true spindle-cell types, eventuating as·a result of malignant transformation of fibro-adenomas. The true adeno-sarcoma presents many variations in structure and is comparatively rare, being often mistaken for a rapidly growing carcinoma with anaplastic spindle-shaped or round cells grouped about the hypertrophied ducts.

Of the pure mammary sarcomas, the spindle-cell type comprises a rather well-defined group. With these, cyst formation is prominent, and combination with other tissue types has been noted. Histologically, their diagnosis is not simple, as very often atypical carcinomas present large areas of spindle-shaped cells. Tumors of this general type presenting marked or short spindle cells are by far the most malignant.

The round-cell sarcomas comprise an ill-defined group in so far as nature and structure are concerned. Again, many growths so classed are atypical carcinomas.

Metastasis.—Regarding metastasis in mammary sarcoma, Denk states that the axillary lymph-glands may become involved but that their involvement is less common than in carcinoma. Flynn says that breast sarcomas are very vascular, but practically without lymphatics, so that they metastasize through the blood-stream. Geist and Wilensky found thirteen cases in

which there was histological involvement of the lymph-nodes, and state that 37 per cent. of cases show recurrences, and 15 per cent. show metastasis. In many instances in which the axillary glands were found to be enlarged, they have shown no histological evidence of malignancy, and it is to be remembered that sepsis from the tumor may produce glandular hyperplasia, which is not due to metastasis. In the sixty-eight cases which we have studied, there was histologically proven metastasis to lymph-nodes in four instances and to the lungs in two.

Geist and Wilensky state that 31 per cent. of their series of 435 cases were spindle-cell sarcomas, 14 per cent. round-cell sarcomas, 12 per cent. cysto-sarcomas, while fourth in frequency were the adeno-sarcomas. Of the cases we reviewed there were more spindle-cell types than any other type.

Clinical aspects, symptoms and diagnosis.—Consensus of opinion seems to favor the view that sarcomas of the breast may remain stationary in size for months or even years after first noticed, and that when growth ensues, it is, as a rule, very rapid, the tumor usually attaining gigantic proportions before the patient comes under the observation of the surgeon. Hamann states that typically the tumor is partly cystic and partly solid, and that the axillary glands are not as a rule involved. While early diagnosis may be difficult, he feels that "a large tumor of the breast, partly cystic, and partly solid, not adherent to the skin and with no axillary adenopathy, is probably sarcomatous."

Denk, from his study of diseases of the mammary gland, concludes that the general health of the patient is usually less impaired in sarcoma than in carcinoma of this organ, in spite of the often more rapid growth of the former, which, in the presence of cystic softening, may reach the size of an average head. He says that diagnosis in the early stages is difficult, but that in the advanced stage the very large tumor, partly cystic and partly solid, covered by a thin, slightly reddened skin, traversed by dilated veins, with free axillary glands, gives a characteristic picture. Flynn is of the same opinion.

Antonioli, in his very thorough and excellent treatise on bleeding breasts and breast tumors, says that with sarcoma, bleeding has been seen in cases which developed polycystic degeneration. He states that Gross, in examining 156 sarcomas of the breast, concluded that in the solid types of sarcoma there is neither hæmorrhagic nor serous secretion from the nipple, but that there may be secretion either hæmorrhagic or serous in the cystic types of sarcomas. He collected seventy-eight such cases. Other authors who are quoted by Antonioli as having reported cases of mammary sarcoma in which bleeding or secretion from the nipple was an important clinical sign, are Billroth, Winslow, Huter, Lebert and Verneuil. Antonioli adds that among twelve cases of cysto-sarcoma studied by Bryant, four showed a distinctly hæmorrhagic secretion. In two cases the secretion was the first symptom, and preceded the appearance of the tumor by three months in one case, and two years in the other. He agrees with other observers, however, that

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bleeding or secretion from nipples is not pathognomonic of any disease, being present in a certain proportion of benign as well as malignant new growths, especially those undergoing polycystic degeneration, or, as an evidence of complementary hæmorrhage. In the cases which we have studied, we have found bleeding from the nipple mentioned only twice.

Flynn calls attention to the fact that in sarcoma of the breast, the nipple is rarely retracted, the skin is never adherent to the tumor, but that ulceration of the skin occurs early and the tumor seemingly hangs away from the chest wall and is freely movable.

All authors agree that histological examination is the only certain method of diagnosis of this tumor, since many clinically benign tumors will, when subjected to careful histological study, reveal sarcomatous areas, and that there are no pathognomonic signs nor symptoms to distinguish the condition clinically from carcinoma.

Treatment.—Sarcoma of the breast is purely a surgical condition. Winslow states that "this condition is malignant and should be treated in as radical a manner as carcinoma." Hamann considers "radical amputation, including removal of the pectoralis major, minor and axillary adenectomy, as the operative procedure of choice." He adds that some authors contend that axillary dissection is superfluous, since axillary metastasis is not the rule. He feels, however, that "since at the time cellular characteristics and degree of malignancy cannot be determined pre-operatively, and since the radical operation will include a more thorough removal of the surrounding vascular connections, it seems the logical choice." Denk is of the opinion that the treatment of mammary sarcoma is the same as that of mammary carcinoma, radical amputation being the operation of choice, with end-results about the same. Flynn likewise recommends the radical operation.

Since the vast majority of the cases recorded are reported almost immediately after operation, it is impossible to make a statement based on clinical observations as to whether or not the radical amputation offers any advantage over the simple mammectomy. In view of the malignant nature of the disease, we feel, however, that radical amputation should be the procedure of choice.

Prognosis.—We find it difficult to draw conclusions regarding the prognosis of mammary sarcoma from the reports of cases occurring in the literature, due to the fact that the vast majority of cases are reported immediately after operation, and the ultimate outcome not recorded. Elliott states that fibromas tend to undergo myomatous degeneration and may develop into periductal sarcomas. He adds that "fortunately, such sarcomas are not very malignant, or are only locally so, for their complete removal usually affects a cure." Caylor and Shugrue report a case of a fibro-sarcoma developing in a fibro-adenoma in a male and mention a similar one recently seen in a female. They feel that these tumors were of a low grade of malignancy. They state that Connell reported eleven cures in thirty-four cases of all kinds of sarcoma of the breast in men. Finsterer, in 1906, reported only

one cure in twelve cases. Geist and Wilensky found that the cystic type of sarcoma of the breast offered the better prognosis, 75 per cent. being cured, whereas with the solid type of tumor, the mortality was as high as 42 per cent. Flynn states, "sarcoma of the breast is generally recognized to be second only to carcinoma as the most malignant pathological lesion of the breast."

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RETROPERITONEAL FIBROMYXOMA

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Retroperitoneal myxoma are very infrequent. In 1921, Von Wahlendorf[1] made careful search of the literature and tabulated 153 cases of retroperitoneal lipomata. Of these, seventy, or 46 per cent., were pure lipomas, while eighty-three were mixed tumors, classified as follows:

31 of the 83, or 20 per cent., fibro lipomata
16 of the 83, or 10 per cent., myxolipomata
15 of the 83, or 10 per cent., fibromyxolipomata
21 of the 83, or 14 per cent., contained sarcoma tissue

Not a single case of myxoma unassociated with fat is recorded by Von Wahlendorf. A careful search of the recent literature has failed to uncover any report of retroperitoneal myxomata not associated with fat. Therefore, inasmuch as a careful examination of the tumor reported here revealed myxomatous and fibrous tissue only—no fat tissue was found—a record of the case may be of interest.

Mixed tumors of the retroperitoneal connective tissue present many unusual features. As Hosemann[2] remarks, "They are not so innocent as they appear." After an apparently complete removal, recurrences are frequent. The growth is often encapsulated and the operator believes that he has removed it in its entirety, but, none the less, there is a recurrence. Careful microscopic examination fails to uncover sarcomatous tissue, yet after one or more returns of the tumor, sarcomatous areas are found. Katz[3] believes that half of these growths reported as benign are malignant. Hosemann and Von Wahlendorf suggest that retroperitoneal lipomata are not single, but develop from several anlage. Minute growths are left behind after the removal of the primary tumor. These daughter growths are very small and are not seen at the operation. Later they develop and it is assumed that there is recurrence when, as a matter of fact, the unrecognized tumors have undergone rapid development.

The etiology of retroperitoneal mixed tumors is speculative. Of the various theories, that of congenital rests receives the greatest support. Other theories are: (1) mechanical irritation due to changes in nitro-abdominal pressure through the filling and the emptying of the bowel; (2) vasomotor disturbances; (3) disturbances in metabolism dependent upon the abuse of alcohol; (4) originating in the lymph-glands. Enlarged glands are frequently removed in the tumor mass, but, so far, no neoplastic tissue has been found in these glands. Just why lymph-glands enlarge without showing metastasis or inflammation is not clear. (5) The result of inflammatory processes.

Ewing,[4] Hertzler,[5] and Ribbert[6] are among those who support the congenital rest theory. Ewing theorizes that mucous tissue is widely distributed in the embryo especially in the subcutaneous tissue, and that myxoma arise from islands of such embryonic tissue. "Since such islands of mucous tissue may be readily associated with cartilage and fibrous and fat tissue, which are normally developed from the embryonal mesoblast, it is reasonable to explain the occurrence of many myxolipomas, fibromas, and chondromas by assuming their origin from islands of tissue which are partially differentiated, or which become so during the progress of the growth. It does not appear that pure myxomas ever tend to differentiate into fibroma or lipoma."

The few reported cases in children may tend to support the theory of embryonic origin. There are records of six cases occurring between the ages of one and six, and one instance in which the tumor was present at birth. Why congenital rests lie dormant for years, and what stimulus initiates their growth, is not known. Hertzler points out that this is the case with adrenal tumors. That trauma is an immediate stimulus is most improbable, and has been suggested only because certain more superficially located malignancies appear to their origin to trauma. I believe that the close relation of injury to the onset of various bone tumors is established. However, retroperitoneal myxomas are situated in regions seldom injured, and not subjected to prolonged irritation.

The site, age and sex incidence of retroperitoneal mixed tissue tumors is given by Von Wahlendorf as follows. In 148 cases we find:

	Women	Men
To 20 years	6	4
21 to 40 years	30	10
41 to 60 years	52	30
Over 60 years	13	4

It is interesting to note that the majority are found in women in a ratio of about four to one, and that two-thirds occur after the age of forty. The location of the tumors is given in 132 cases. Of these, 104 arose in the upper retroperitoneal space generally developing from the retroperitoneal fat. Twenty-eight were attached to the retroperitoneal tissue of the pelvis, while only fifteen originated in the true pelvis, from the fat in the hollow of the sacrum.

Retroperitoneal myxoma are remarkable in that they often attain a large size without causing the patient any considerable discomfort. The subject of this report had a growth as large as a child's head, weighing over 2900 grams, which gave rise to little distress. These tumors are among the largest found in man, and are known to have attained a weight of thirty to forty kilos. It is remarkable that life can exist in the presence of such huge growths. Many are discovered accidentally. The most constant complaint is a sense of weight, or heavy feeling in the abdomen. There is vague discomfort. Digestion may or may not be disturbed. Often this amounts to no more than belching gas after meals. The intestines may continue to

function in a normal manner until the tumor is very large indeed. Anæmia, loss of weight and loss of strength occur late in the disease, although, after a time, nutrition fails and the growth increases rapidly, and, as Well[7] remarks, "holds up protein and stores fat at the expense of the wasting body." Finally, pressure phenomena are noted. Impared circulation in the abdominal veins, cava, iliacs, leads to œdema of the extremities, and dilatation of the veins of the abdominal wall. The free action of the diaphragm is hampered, with resulting dyspnœa. In certain instances, the kidneys are destroyed, and uræmia ensues. Again the ureters are constricted, hydronephrosis develops, and renal tissue is destroyed. Ascites is a late occurrence. Metastases take place late and in some cases have not been present.

The prognosis is bad. Keen's[8] Surgery states that the duration of life in unoperated cases is from two to three years after discovery of the growth, also that occasionally spontaneous cessation takes place after partial removal. This latter statement I am unable to confirm from other sources in the literature. Indeed, the authors are most emphatic in stressing the danger of recurrence after seemingly complete removal. The prognosis after operation should be most conservative. The immediate operation mortality, according to Von Wahlendorf, is 14 per cent. in 113 operated cases, and tabulates sixty as cured. This latter statement is much too optimistic, and does not bear close scrutiny. Pritzi,[9] on the other hand, gives the operation mortality in patients operated upon since 1910 as being 7½ per cent. This improvement has been brought about by better surgical technic.

Retroperitoneal mixed tumors present great diagnostic difficulties. We must differentiate between ovarian cysts, uterine tumors, renal tumors, hypernephroma, cysts, hydronephrosis, pancreatic cysts, mesenteric cysts and tumors, and occasionally gall-bladder and wandering spleen. Incidentally, most patients have been operated upon under the diagnosis of one of the above-mentioned possibilities. Retroperitoneal myxomas are so rare that a surgeon is fortunate if he encounters three or four cases. Many operators with large practices have never seen a case. This lack of experience explains most of the failures to make the correct diagnosis. Schmid[10] reports forty-six collected cases operated upon under the diagnosis of ovarian cyst. He also says that with the abdomen open the diagnosis is not always easy.

When confronted with an abdominal tumor of uncertain origin, what can we do to aid us in reaching a diagnosis? History will aid in limiting the possibilities, and should be carefully taken. Retroperitoneal mixed tumors, as previously stated, occasion very little distress and frequently attain a large size before the physician is consulted. Loss of weight and anæmia are late manifestations. Therefore, it is unlikely that a malignant tumor, as ordinarily understood, could reach such proportions without causing more general disturbance. A history of menstrual irregularities would direct attention to the reproductive organs. Likewise, pyuria and hæmaturia point toward the kidney. Pancreatic cysts often are antedated by severe upper abdominal distress; likewise hydrops of the gall-bladder will usually be suggested by the

history. After the history has centered our attention on two or three possibilities and removed the rest of our immediate consideration, we proceed to the physical examination.

Retroperitoneal mixed tumors are fixed unless a portion of the growth has penetrated the leaves of the mesentery when mobility is marked. Their surface is smooth, although often lobules can be palpated. Pressure causes little or no pain. The consistency is semi-solid, and one often elicits a sense of fluctuation which leads to our erroneous diagnosis of ovarian cyst. The next diagnostic step is to determine the relation of the colon to the tumor. Retroperitoneal growths generally displace the colon toward the midline. This can be demonstrated with a barium enema and the X-ray. Pyelography is of great value in differentiating renal neoplasm and should be employed in reaching a diagnosis. Choleocystographs could be made if, as seems most unlikely, gall-bladder pathology should come into question in the differentiated diagnosis. Wandering spleens should be diagnosed through palpation and it seems unlikely that confusion should arise, Schmid says that a wandering spleen was the diagnosis when operation revealed a retroperitoneal mixed tumor. Evidently the diagnosis is one of elimination and at best will be uncertain. Perhaps if we determine that the tumor is retroperitoneal, and keep the possibility of myxoma in mind, we may be permitted to make a tentative diagnosis of retroperitoneal myxoma.

Having reached a probable diagnosis, what is the therapy? Unless the general condition of the patient is such as to forbid operation, removal should be attempted despite the chance of meeting with great difficulties. The operation may be relatively easy or attended with the greatest difficulty. R. Hofstalter and H. Schnitzler[11] report that out of fifty-six cases in which operation was undertaken, eleven were abandoned because of insurmountable technical difficulties. The kidney is often so involved in the growth that it must be sacrificed. Hence cystoscopic examination in cases presenting growths in the upper abdomen should be made without fail. It is a great comfort to the surgeon to know that the opposite kidney is competent. Again, the ureter may be accidently severed. Intestinal resection may be required either because in removing the mass, the blood supply to a loop of bowels has been damaged, or because the intestinal wall has been lacerated. It is recorded that the vena cava has been torn, and, according to Von Wahlendorf, in several instances the operator has repaired the rent with happy outcome. In one instance the aorta was torn. One can readily understand how these accidents can happen. The huge growths make exposure difficult. They are in close relationship to these vital structures and by their very mass hinder the surgeon in obtaining clear exposure. It is unfortunate that the patients suffer so little discomfort that they do not consult a physician until the tumor has reached a large size. Unquestionably the earlier the operation the better is the prognosis, both immediate and late. Infection, which caused so many deaths in earlier times, is no longer so great a hazard. Better anæsthesia further reduces the risk of operation.

Methods of combating shock, which was responsible for a number of deaths in the earlier operations, will save patients who some years ago would have succumbed. Therefore, if the patient's condition is reasonably good, we should recommend operation, knowing that surgery offers the one chance.

Röntgen-rays have been tried, both pre- and post-operative, and no one claims that they have been of value. Perhaps they should be used after the patient has recovered from the operation. R. Hofstalter and H. Schnitzler report a treatment several months with X-rays before operation was done, but without the least benefit resulting. The tumor continued to increase in size.

Mrs. E. J., aged thirty-nine, consulted her physician in March, 1930, on account of a tumor of the lower abdomen. She first noticed this mass in January, 1930, at which time the upper limit was just above the symphisis. The tumor, in spite of a rapid growth during the next two months, occasioned very little discomfort. There was increased urinary frequency, which appeared to have begun in November, 1929. However, following the birth of her first child seven years ago, the patient had had more or less bladder irritability and she was not disturbed when this symptom became a little more pronounced. She experienced a vague sense of discomfort in the abdomen, and at times noticed a few short, cramplike pains in the lower abdomen. These pains came soon after eating, but did not last long. Her bowels acted without cathartics and her general health continued good. Both the patient and her husband were positive that her weight had increased during the past six weeks, and her acquaintances had remarked upon her healthy appearance.

In October, 1929, her menstrual period lasted but one day, and a physician, consulted at this time, suggested the possibility of pregnancy, but unfortunately did not make an examination. The patient was certain that no abdominal tumor was present, so we may assume that the growth had not attained a size large enough for the patient to find. The menses in December, January, and February were not remarkable.

The past history had no bearing on the present illness. The patient has always enjoyed good health, and denied any serious illnesses. There was no history of miscarriages nor operations or serious injuries. Her husband and two children, three and seven years of age, are all in good health. Her confinements were uncomplicated, spontaneous delivery and normal puerperium. However, as noted above, since the birth of the first child, there has been more or less bladder irritability.

The family history disclosed the following facts: Father died—seventy years—cause unknown. Mother died—sixty years—carcinoma of stomach. Two brothers are living and well. No sisters.

The patient is a well-developed, well-nourished woman, five feet, six inches tall, weighing 160 pounds. The mucous membranes are of good color and do not suggest anæmia. The lower abdomen is symmetrically distended. Palpation reveals that this distention is due to a rounded tumor, which extends to the umbilicus. This mass pretty well fills the lower abdomen, is fixed, semi-solid, smooth, and irregular enough to suggest lobulation. Palpation is painless except at the upper mid-portion of the tumor, where pressure elicited a little tenderness. At operation, this portion was seen to be the site of an old hæmorrhage. Omentum and ilium were adherent at this point, and this probably explains the tenderness.

Vaginal examination showed a perineal tear of grade 1. The cervix was slightly irregular, pushed up under the symphisis, and of average firmness. The fundus uteri could not be found. The entire pelvis was filled with a fixed semi-solid tumor mass, extending to the umbilicus. The adnexa were not made out. On bimanual examination, there was a suggestion of fluctuation. One got the impression that the tumor might

contain fluid under considerable tension. Certainly the mass was softer than one would expect a fibroid to be. The rest of the physical examination showed no further pathology. No free fluid was found in the abdomen. The liver and spleen were not enlarged. Heart and lungs were normal. No glandular enlargements were found. The laboratory reported that the urine was free from abnormal constituents, that the red count was 4,900,000, hæmoglobin 95 per cent. Talquist and the white count 8,200.

Exploratory operation was advised and accepted. On March 14, 1930, under ether-gas anæsthesia, the abdomen was opened through a long left rectus incision. A smooth, glistening, white-yellow mass was seen filling the pelvis. No free fluid was noted. The omentum was adherent to the upper posterior surface of the growth to the distance of almost four inches; this was ligated. Then a loop of ilium was dissected free, the intestines were packed away and an attempt made to deliver the tumor. This was impossible. The uterus was next located, with some difficulty, in front of the mass, pressed tightly against the symphisis pubis. The ovaries and tubes were identified, and it was seen that the tumor was not connected with these structures, but that it had its origin in the hollow of the sacrum. The peritoneum was incised transversely in front of the mass as low down as possible, a plain of cleavage found, and we were able to enucleate the mass intact, except at its very base. The removal was surprisingly easy. The vessels were secured, and a pack placed in the hollow of the sacrum to control oozing. The right ureter was bared for a matter of two inches, and appeared to be a little increased in diameter, but otherwise not remarkable. A strip of gauze protected with rubber dam was placed against the denuded hollow of the sacrum to control the oozing from a number of very small vessels. The patient left the table at the end of fifty minutes, and proceeded to make an uneventful recovery. The total amount of blood lost was very moderate. The main vessels came from the side of the pelvis, and were caught with the peritoneum, as it was cut around the base of the tumor. They were disproportionately small in comparison with the size of the mass—strikingly so. The greatest difficulty in the technic was in getting exposure.

The tumor was encapsulated, and weighed 2,900 grams. One tubule on the superior anterior surface showed dark discoloration from hæmorrhage, and this lay directly beneath the tender area of the abdominal wall. On section, the tumor was composed of a number of lobules, varying in size from that of an English walnut to that of an egg. They were silver-white in color, smooth, soft and loosely joined together with connecting tissue. Individual lobules could be easily removed and peeled out from the growth. Indeed, the tumor resembled a sac of many small tumors, lightly adherent one to the other. Later a mucoid sticky fluid began oozing from the cut surface. No cysts were found, as have been reported as occurring in retroperitoneal mixed tumors. There were a few firm areas, which the microscopic examination showed were made up of fibromatous tissue.

Dr. A. R. Moritz reports as follows:

The specimen (Fig. 1) consists of an encapsulated, irregularly lobulated, firm, translucent mass of tissue weighing 2,900 grams after formalin fixation. Several portions of the tumor had been separated from the whole so that it is not possible to establish the continuity of the capsule. Where the tumor is intact, however, the capsule appears thin, smooth, and shows no evidence of invasion. The density of the tumor varies, being in places quite solid and in places almost of cystic consistency. The more solid areas are the more opaque and many small blood-vessels can be seen at a considerable depth beneath the surface. Only in one place can any blood-vessels be seen to enter the tumor and these are not invaded by tumor tissue. Adherent to the outer surface of the tumor are some small lobules of adipose tissue having the appearance of omentum.

On section a large amount of tenacious mucoid material exudes from the cut surface. This material was clear and transparent. The areas of greatest density were relatively dry, appeared fleshy in contrast to the acellular mucoid areas and were covered by thicker capsule than seen generally. Although the vascularization of the tumor was

prominent because of its translucency, the surface did not bleed and the general impression was gained that the tissue was quite avascular.

Histological examination.—A number of sections were taken, including both central and peripheral portions of the tumor and cellular and acellular areas, characteristic of
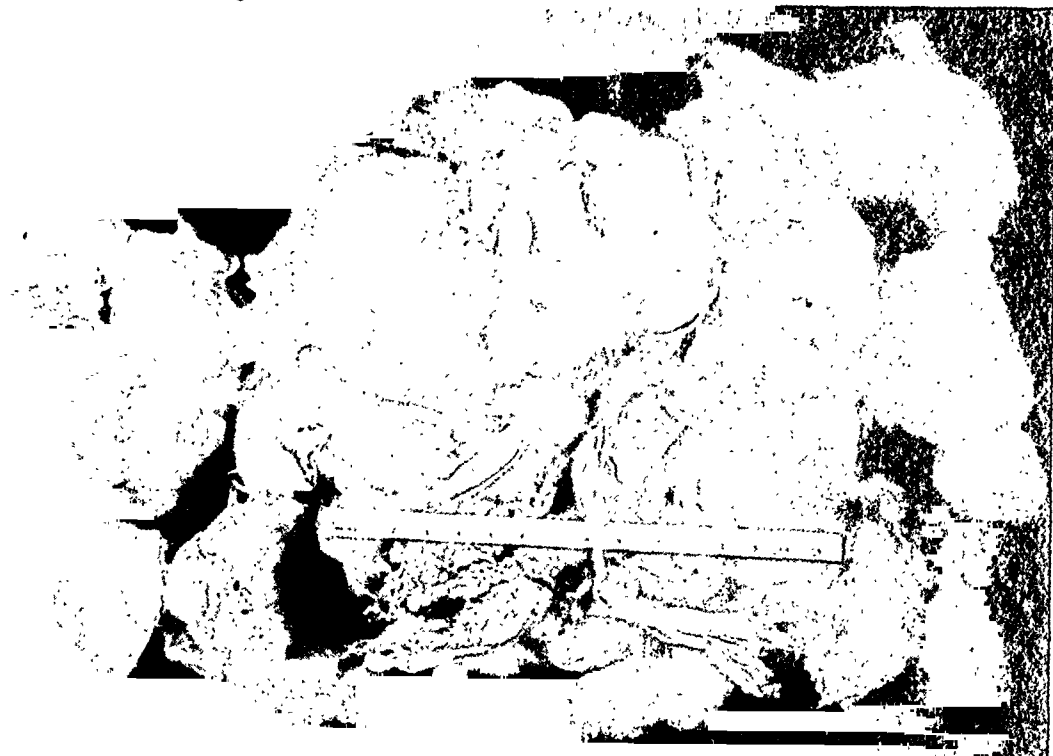
FIG. 1.—Retroperitoneal Fibrolepoma.

the specimen were the sections taken from the relatively acellular translucent areas and they were comprised chiefly of a finely fibrillar, slightly basophilic matrix distributed throughout which were uniform, stellate outlined cells having multiple irregular cytoplasmic processes which appeared to anastomose one with another. It was in the
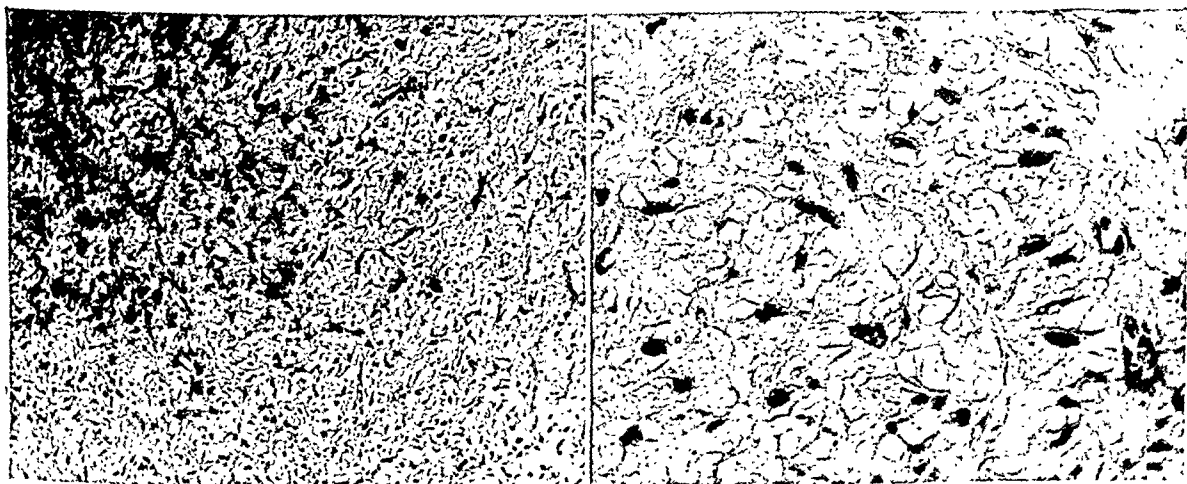
FIG. 2.—Fibromyxoma. Magnification x120.

FIG. 3.—Fibromyxoma. Magnification x600.

interstices between these processes that the basophilic material was deposited. The cytoplasm of these cells was acidophilic. The nuclei varied in size and shape, were hyperchromatic and were relatively small. Supporting the tumor were fairly regularly disposed fibrous trabeculæ carrying thin-walled blood-vessels and these trabeculæ appeared to be formed by condensation of the cells constituting the tumor. Scattered throughout the tissue were large, round, endothelial cells.

Other areas of tumor showed variations from this picture which were relative. In some areas the cells were thickly disposed, showed more nuclear irregularity and the cytoplasm was in some instances confluent to suggest syncytial cell masses. Along with the variation in size and shape of nuclei there were occasional but infrequent mitoses. There was no evidence of blood vascular invasion. Other portions of the tumor showed an acidophilic rather than a basophilic matrix, this matrix having the appearance of hyaline.

The inner structure of the tumor is shown, after dividing the mass into two parts. Various sized lobules are seen, while under and below the rule there is a portion of the resected omentum, which was adherent to the growth. Portions of the capsule are seen.

This report has been prompted by the fact that a reasonably careful search of the literature has failed to reveal a single case of pure retroperitoneal fibromyxoma. All cases reported were mixed lipomas. We are satisfied that this tumor does not contain any areas of lipoma tissue; that a sarcomatous area has been overlooked is probable. We hope that calling the attention of the profession to retroperitoneal mixed tissue growths will make us think of this possibility when next confronted with an abdominal tumor of uncertain etiology. It is to be noted that the growth was cut in half before a picture was made. Thoughtless interest to see the inside of the tumor led us to lay it open immediately after removal. Encapsulation was complete except at the point of origin in the hollow of the sacrum. The infrequent occurrence of these tumors, their difficulty of diagnosis, their unusual features of rapid growth tending to recurr after apparently complete removal and the operative hazards, warrant placing this case on record.

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TETANUS IN NEW ORLEANS

AN ANALYSIS OF 813 CASES

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IT IS the purpose of this paper merely to emphasize certain important points and record statistical data on 813 cases of tetanus which have been admitted to the various surgical services of the Charity Hospital of Louisiana, at New Orleans, from 1906 to 1930. Gessner,[6] in 1918, reviewed 368 of these cases, and in 1923 Graffagnino[7] reported 596 cases, which included those previously presented by Gessner.[6] Since 1923 there have been 217 additional cases admitted to the Charity Hospital, making a total of 813 cases for consideration.

Sites of wounds.—In comparing the mortality rates (Table I) for tetanus developing from various wound sites, it will be noted that those of the upper extremities were attended with a mortality rate of 67.6 per cent. and those of the lower extremities by a mortality rate of 55 per cent. This is as would be expected, but in contradistinction to other reported series the mortality rate for five cases following wounds about the head and face was only 40 per cent., and for four cases due to infected teeth it was only 25 per cent.

TABLE I

Sites of Wounds

Site of wound	Graffagnino's series	New series	Mortality per cent new series
Lower extremities	352	111	55
Upper extremities	83	37	67.6
Head and face	32	5	40
Teeth	1	4	25
Back	9	..	..

Types of injuries.—In fifty-two cases of tetanus which developed from a nail puncture wound the mortality rate was 67.3 per cent., whereas in fifty cases in which the wound was produced by a splinter, it was only 46 per cent. In seven cases of tetanus neonatorum, in two cases of tetanus occurring post-partum, in three occurring in morphine addicts, and in six in patients who had had criminal abortions, the mortality rate was 100 per cent. (Table II).

Blank cartridge wounds deserve special comment. There were twenty-four cases of tetanus due to such wounds, and the mortality rate in these was 83.3 per cent. Certainly such a high incidence of tetanus and high mortality rate are sufficient arguments for the abolition of such a dangerous and needless method of celebrating Christmas week and Independence Day.

It is probably not generally appreciated that the wool wadding used in blank cartridges is nearly always contaminated with tetanus spores or bacilli,

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TABLE II

Types of Injuries

Type of injury	Graffagnino's series	New series	Mortality per cent. new series
Splinter........................	163	50	46
Nail............................	122	52	67.3
Incised wound...................	44	..	..
Crushed wound..................	42	..	..
Brush burns.....................	38	..	..
Tetanus neonatorum..............	36	7	100
Punctured wounds (excluding nails).	16	2	50
Firecrackers, blank cartridges, and airgun........................	23	..	..
Blank cartridges.................	..	24	83.3
Abortions.......................	15	6	100
Postpartal......................	..	2	100
Morphine addicts................	9	3	100
Compound fractures..............	..	2	50
Ulcer...........................	3	1	100
Gangrene of toe.................	..	1	100
Amputation of stump............	..	1	100
Cancer of breast—post-operative....	..	1	100
Furuncle.......................	1	..	..
Vaccination.....................	1	..	..
Extraction of teeth..............	..	3	33.3
Gunshot wounds.................	6	3	100

as is most woolen clothing through which so many injuries are sustained. In treating wounds one is prone to associate with tetanus only those which are received in the garden or stable. There is no doubt that many clean foreign bodies carry with them tetanus spores from woolen clothing, which they penetrate to inflict an injury. Wounds received in such a manner at least deserve a débridement.

Incidence by months.—The incidence of tetanus by months in this series (Table III) is in accordance with other series in that tetanus appears to be a disease of the open season. The highest incidence was for the summer months with almost as many cases occurring in December and January. The high incidence for these two winter months is explained by the fact that in New Orleans many gunshot and blank cartridge wounds are received from Christmas Day to and through New Year's Day.

An interesting observation in this study concerning incidence of tetanus by months as shown in Table III is that for the twenty-three cases admitted in September the mortality rate was only 8.7 per cent., whereas in other months it was many times higher. There is no apparent explanation of this.

Incubation period compared with mortality rate.—In this series the lowest mortality rates occurred in those cases in which the incubation period was from ten to twenty-one days. The increase in mortality rate as shown in Chart I for cases with incubation periods of over three weeks is probably due to the presence of foreign bodies and suppuration in the wounds.

Prophylaxis and the incidence of tetanus.—Eight cases in the present

series (Chart I) had received one prophylactic dose of antitetanic serum. In only three of these was the incubation period of more than three weeks, being

Number of Days Incubation Period

	2–6	6–9	9–11	11–15	15–18	18–22	22–35	35–45	45–55	55–65	180
Cases	76	218	77	106	30	54	25	3	1	4	1
Cured	9	51	33	49	16	30	15	1	1	2	1
Died	65	157	44	47	14	24	10	2	0	2	0
Per Cent	85.5	72	57	44.3	46.6	44.4	66.6	66.6	0	50	0
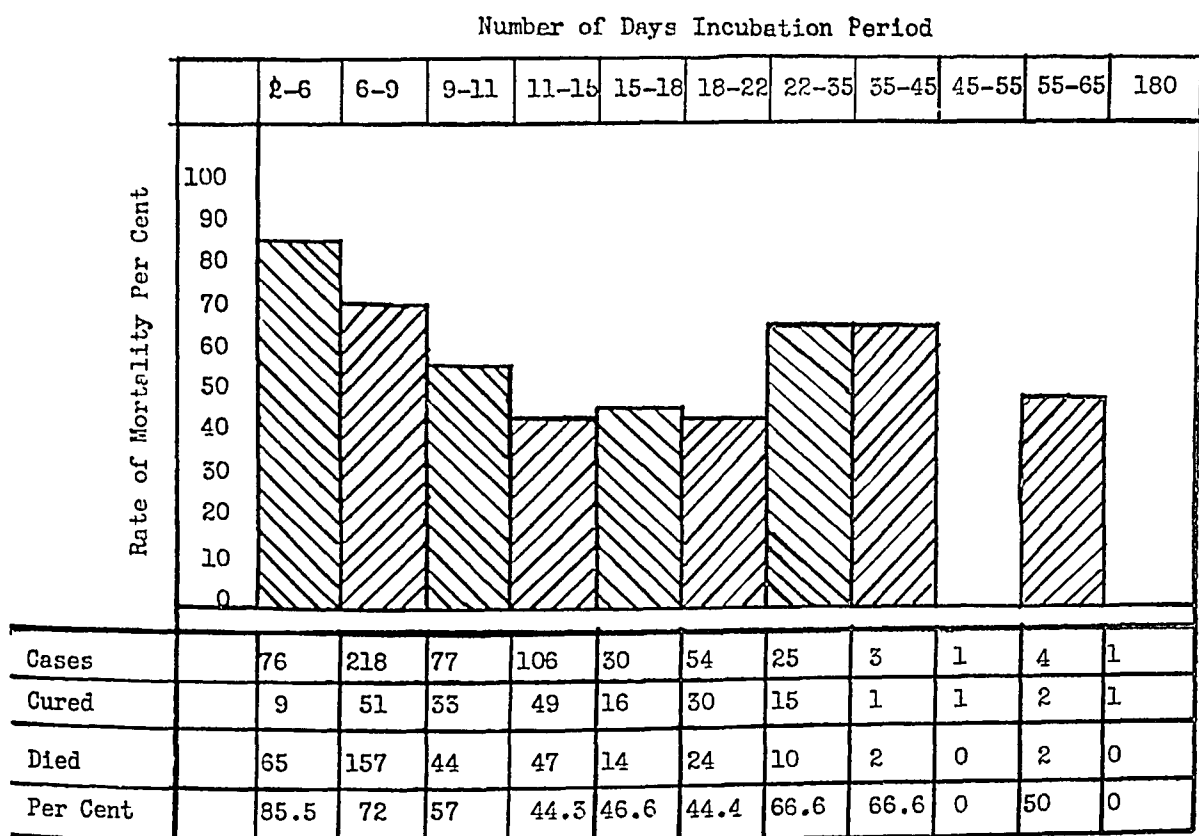
CHART I.—Incubation periods with mortality rate.

twenty-eight, sixty and sixty days, respectively. Four of these eight cases died.

That a prophylactic dose of antitetanic serum will frequently prevent the development of tetanus was conclusively established in the Great War. In

TABLE III

Incidence of Tetanus by Months with Mortality Rate

Months	Cases	Discharged	Died	Mortality per cent.
January	27	6	21	77.7
February	7	5	2	28.5
March	19	7	10	52.6
April	13	6	7	54
May	15	5	10	66.6
June	21	8	13	62
July	17	10	7	41
August	27	10	17	63
September	23	21	2	8.7
October	22	10	12	54
November	7	4	3	43
December	16	4	12	75

the United States army, 1,500 units of antitetanic serum were given routinely to all wounded, and this dose was repeated after seven days whenever there was the slightest indication. Such prophylaxis,[3] in combination with proper

care of the wounds, kept the incidence of tetanus down to thirty-six cases in 224,089 wounded soldiers, or one case for each 6,224 wounded. In the Civil War, Sanford[8] states that there was one case of tetanus for each 487 wounded, or 505 cases in 246,172 wounded.

Sir David Bruce[9] reports that in 2,032,142 wounded British soldiers tetanus developed in 2,385 or in 1.17 per thousand. In October, 1914, the incidence was thirty-two for each 1,000 wounded, but in November, when the administration of antitetanic serum was begun, the incidence immediately dropped to about two per thousand and remained so throughout the war.

Prophylaxis and the incubation period.—That the administration of one prophylactic dose of antitetanic serum will greatly prolong the incubation period in those cases destined to develop tetanus is improbable. The anti-toxin remains in the blood-stream approximately eight days and is then *rapidly and completely excreted by about the tenth day. It is, therefore,* reasonable to assume that such a prophylactic dose can only prolong the incu-

TABLE IV

Mortality Rate by Years

Period	Cases	Discharged	Died	Mortality per cent.
1840–49 (Incomplete)	16	5	11	68.7
1850–59	87	17	70	80.4
1860–69	57	14	43	75.4
1870–79	75	17	58	77.3
1880–89	81	13	68	83.9
1890–99	150	33	117	78
1900–05	101	35	66	65.3
1906–09	72	19	53	73.6
1910	33	7	26	78.8
1911	28	9	19	67.9
1912	33	8	25	75.8
1913	44	11	33	75
1914	51	15	36	70
1915	61	22	39	63.9
1916	33	13	20	60
1917	48	16	32	66.6
1918	17	7	10	58.8
1919	38	14	24	61.2
1920	44	10	34	77.3
1921	46	21	25	54.3
1922	48	19	29	60
1923	39	15	24	61.5
1924	37	13	28	75.7
1925	25	13	12	48
1926	31	24	7	22.5
1927	32	13	19	59.3
1928	29	12	17	58.6
1929	24	13	11	45.8
1840–1905	567	134	433	76.4
1906–1922	577	188	389	67.4
1923–1929	217	103	114	52

bation period for the short period that it is in the blood-stream. For this reason, the antitetanic serum should always be repeated on about the seventh day whenever a wound is a favorable one for the development of tetanus. That one prophylactic dose of serum does not greatly influence the length of the incubation period is substantiated by the fact that in 343 cases which occurred in British soldiers in France the average incubation period was, according to Cummins and Gibson,[10] 13.2 days. In the British "home hospitals," where prophylaxis was adequately repeated and where there was the influence of other factors, the average[11] incubation period was 45.5 days.

Prophylaxis and mortality rate.—That the prophylactic use of antitetanic serum lowers the mortality rate in those who develop tetanus is well established, but it is probably not generally appreciated that the proper care of the wound in which tetanus is apt to develop is more important than the administration of serum. Serum protects the individual for only a week, whereas proper and adequate care of the wound removes all possibility of the development of the infection. Many reports of cases with long incubation periods substantiate this. Débridement should be performed on all wounds in which there is a possible contamination with tetanus bacilli, and in most cases the wound should be left wide open and drainage not hindered by the application of a tight bandage.

When one compares the mortality rate of 67.4 per cent. from 1906 through 1922 with the rate of 52 per cent. from 1923 through 1929 and considers that in the former period half the cases received no antitetanic serum at all and that only eight patients were given over 50,000 units, it would seem that more adequate serum therapy in the latter period is responsible for the decrease in mortality rate. This decrease in the mortality rate is largely due to the disproportionate decrease in the number of deaths occurring in children under thirteen years of age. (Tables V and VI.)

TABLE V

Mortality Rate by Years in Children Under Thirteen Years

Period	Cases	Discharged	Died	Mortality per cent.	Cases omitted
1906–22	310	106	204	65.8	10 questionable
1923	17	5	12	70.5	
1924	20	12	8	40.0	
1925	15	11	4	26.6	
1926	21	17	4	19.0	1 tetanus neonatorum
1927	13	7	6	46.1	3 tetanus neonatorum
1928	14	7	7	50.0	
1929	13	7	6	46.1	2 tetanus neonatorum
1923–1929	113	66	47	41.5	

Tables V and VI demonstrate that the mortality rate in adults from 1906 to 1922, inclusive, was 70 per cent. or only 4.2 per cent. higher than it was in children for the same period. In this series the average dose of

TABLE VI

Mortality Rate by Years in Adults

Period	Cases	Discharged	Died	Mortality per cent.	Cases omitted
1906–1922	286	84	202	70.0	
1923	22	10	12	54.5	3 died within 8 hrs.
1924	17	1	16	94.1	1 died within 8 hrs.
1925	10	2	8	80.0	1 died within 8 hrs.
1926	10	7	3	30.0	3 died within 8 hrs.
1927	19	6	13	68.4	1 died within 8 hrs.
1928	15	5	10	66.6	
1929	11	6	5	45.4	.
1923–29	104	37	67	64.4	

antitetanic serum administered was about 13,000 units per patient given serum therapy.

Antitetanic serum therapy.—Since 1923, moderately large doses of serum have been used, and the mortality rate in children has decreased from 65.8 per cent. to 41.5 per cent., whereas in the adults it has merely dropped from 70 per cent. to 64.4 per cent. The children actually received relatively larger average total doses (48,000 units) of antitetanic serum for their body weight than did the adults (average 52,400). This fact might suggest itself as the cause for the greater lowering of the mortality rate in children, but it should be recalled that the dose should not be estimated on the size of the patient, but on the amount of toxin which is thought to be in the blood-stream. In contrasting such large series as these, it is fair to assume that the virulence of foci of tetanus infections averaged about the same.

Table VII is reproduced from Graffagnino's 1906–1923 series to show in 577 cases the effects of various doses of antitetanic serum compared with those obtained without the use of serum. In this series the mortality rate for

TABLE VII

Dosage and Mortality Rate in Graffagnino's Series

Dose of serum	Cases	Discharged	Died	Mortality per cent.
501–1,000 units	4	1	3	75
1,001–10,000 units	202	68	134	66.3
10,001–20,000 units	32	9	23	71.8
20,001–50,000 units	27	10	17	63.0
50,001–100,000 units	6	2	4	66.6
Over 100,000 units	2	1	1	50.0
No serum used	304	97	207	68.0
Serum used	273	91	182	66.6

Average dosage 13,000 units

the 304 cases which did not receive antitetanic serum was 68 per cent., whereas in the 273 cases treated with serum it was 66.6 per cent. or only 1.4 per cent. lower in those who received serum therapy. As it is evident

that small doses (average 13,000 units per patient) of serum were given, a marked change in the mortality rate could hardly be expected. If it is assumed that in many instances serum therapy was given to the more severe cases, there would be less reason to expect a lowering of the mortality rate.

The mortality rates since 1923 for children on various dosages of serum are shown in Table VIII. The larger doses have not produced an unusually low mortality rate except in the eight cases which were given 90,000 to 120,000 units of antitetanic serum. All of these recovered, but this is of no great significance because of the small number of cases. In this recent series of children the average dose of antitetanic serum was 48,000 units per patient, whereas in Graffagnino's series the average was 13,000 units. In the recent series, the mortality rate was 41.5 per cent. in contrast to 65.8 per cent. in Graffagnino's series. This would seem to indicate that larger doses of antitetanic serum are distinctly of value in children.

TABLE VIII

Mortality Rates of Various Doses of Serum for Children Only from 1923 through 1929

Units of serum	Cases	Discharged	Died	Mortality per cent.
500–19,999	11	6	5	45
20,000–39,999	27	13	4	51.5
40,000–49,999	24	18	6	25.0
50,000–59,999	11	7	4	36.6
60,000–89,999	26	13	13	50.0
90,000–119,999	8	8	0	0.0
120,000–155,000	3	1	2	66.0
180,000	1	1	0	0.0
No serum used	3	0	3	100.0
	114	66	47	41.5

Average dose of serum used: 48,000 units per patient.

Examination of the hospital records reveals that in many cases 40,000 units of antitetanic serum were administered to children on admission. It is not improbable that many of the moderately severe cases improved after the administration of this dose and were, therefore, given no more serum, whereas many of the more severe cases which did not improve were given additional small doses at a time when it was too late to be effective, thus increasing the mortality rate for those receiving larger total doses. Twenty-four children were given from 40,000 to 50,000 units of antitetanic serum and of this number only six, or 25 per cent., died. Because of this favorable mortality rate, one might conclude that an initial dose of 40,000 units is probably adequate for a child who has developed a moderately severe case of tetanus after a long incubation period. But the more severe cases which develop after a short incubation period certainly should receive much larger initial doses of serum and serum therapy should be continued until there is marked symptomatic improvement.

A comparison of the adult mortality rates in this series for various dosages of antitetanic serum (Table IX) makes it evident that the amount of antitetanic serum given made little or no difference except in the nine cases receiving 120,000 or more units in which the mortality rate was only 33.3 per cent.

TABLE IX

Adult Mortality Rates and Serum Dosage

Dosage of serum	Cases	Discharged	Died	Mortality per cent.
10,000–19,999	6	I	5	83.0
20,000–39,999	23	7	16	70.0
40,000–59,999	17	10	7	41.0
60,000–89,999	25	6	19	76.0
90,000–119,999	11	3	8	72.0
120,000–149,999	6	3	3	50.0
203,000–240,000	3	3	0	0.0
No serum 1922–29	13	3	10	77.0
With serum 1922–29	104	37	67	64.4
With serum 1906–22	273	91	182	66.6
Average dosage.	13,000			
No serum 1906–22	304	97	207	68.0

Average dosage: 52,400 units.

Comparison of the mortality rates of 68 per cent. for 304 adult cases which received no serum from 1906 to 1922, with that of 64.4 per cent. for 273 adult cases which received moderately large total doses of antitetanic serum (average 524,000 units per patient) suggests that serum therapy is of little or no value. But when it is recalled that the child mortality rate dropped from 65.8 per cent. to 41.5 per cent. when moderately large doses of antitetanic serum were given, it would seem that it is not the serum at fault but probably the amount given.

Examination of the hospital records suggests that frequently the initial dose of antitetanic serum given was not large enough and in many cases it was evident that the administration of serum was not repeated at all, not often enough or not soon enough.

That antitetanic serum used therapeutically greatly lowers the mortality rate in tetanus has never been conclusively proven. However, most surgeons are afraid not to use it and favorable enough statistics have been accumulated to justify its use.

Poland[12] found in the "pre-serum" days a mortality rate of 84.2 per cent. in sixty-three cases at Guy's. In 1870–71 the German military mortality rate was 90 per cent. in 350 cases.

Wainwright[4] reviewed the literature and found a mortality rate of 64 per cent. in 537 cases not treated with antitetanic serum as compared with 41 per cent. in 806 cases treated with serum.

Miller[5] reports that ninety-six cases of tetanus were admitted to the Massachusetts General Hospital since 1896. In these the mortality rate was 67.7 per cent., whereas in the twenty-five cases admitted since 1916 the mortality rate was 52 per cent. From

his five case reports it is apparent that his cases received 100,000 or more units of antitetanic serum intravenously and intraspinally.

Freelander[2] reports a mortality rate of 36 per cent. in twenty-five consecutive cases treated with massive doses of antitetanic serum given intravenously. He suggests that the average case should be given 315,000 units.

Ashhurst[1] reports a mortality rate of 38.8 per cent. in eighteen cases treated with moderately large doses of antitetanic serum given intraspinally in combination with other routes.

Stone[3] reports a mortality of 53 per cent. in forty-nine cases admitted to Los Angeles County Hospital. He advocates a total average of 125,000 units of antitetanic serum per patient to be given intraspinally and intravenously. He records a mortality rate of 35.6 per cent. for fourteen cases which received from 60,000 to 350,000 units of antitetanic serum.

Routes of administration of serum.—It is regretted that this series offers no information of value as to the best route for administration of antitetanic serum. In all cases, serum was given by the combined intravenous and intramuscular routes. In many it was given subcutaneously as well. In only thirteen was it given intraspinally and in these it was given in combination with other routes. The mortality rate in these thirteen cases was 46 per cent.

The intraspinal administration of antitetanic serum combined with other routes has been attended with good results in the small series of Ashhurst,[1] Stone,[3] and Miller,[5] but results from its use in larger series are less favorable.

Cummins and Gibson,[10] in reporting statistics on British army patients with tetanus in France, found a mortality rate of 68.2 per cent. for 360 cases treated intrathecally alone or in combination with other routes as compared with 64.5 per cent. for 164 cases not treated intrathecally.

Bruce,[9] in a report on tetanus infection which occurred in British "home hospitals," found a mortality rate of 32.9 per cent. for 804 cases treated intrathecally alone or in combination with other routes as compared with 20.8 per cent. for 585 not treated intrathecally.

Wainwright,[4] in an analysis of cases collected by questionnaire, found a mortality rate of 61.7 per cent. for 243 cases treated intrathecally alone or in combination with other routes as compared with 52.2 per cent. for 297 not treated intrathecally.

SUMMARY

A total of 813 cases of tetanus are reviewed with a more detailed study of the 217 cases which recently have been admitted to the Charity Hospital of Louisiana.

In this series it is found that tetanus developed more frequently from wounds of the lower extremities than from wounds of the upper extremities, but that the mortality rate was 12.6 per cent. higher in the latter group.

Of the common wounds the highest incidence occurred in nail puncture wounds which were attended by a mortality rate of 67.3 per cent. This mortality rate was only 16 per cent. lower than that which occurred in twenty-four cases of tetanus which developed from blank cartridge wounds. In seven cases of tetanus neonatorum and the few cases developing postpartum, in morphine addicts, and after abortions, the mortality rate was 100 per cent.

More cases of tetanus occurred in the summer than in the spring and fall, but in contradistinction to other reported series the months of December and January had a high incidence due to the many gunshot and blank cartridge wounds which were received during the Christmas holidays. For no apparent reason twenty-three cases admitted in September had a mortality rate of only 8.2 per cent.

The greatest number of cases of tetanus developed after incubation periods of from six to fifteen days, and the lowest mortality rate occurred in those cases developing after incubation periods of from ten to twenty-one days. Four deaths occurred in eight cases which had received prophylactic doses of antitetanus serum.

The importance of repeating the prophylactic dose of antitetanic serum every seven days is emphasized as it has been found that antitetanic serum protects the patient likely to develop tetanus only for the eight to ten days that it remains in the blood-stream.

The Charity Hospital mortality rates in tetanus by years are shown not to have varied markedly from 1840 to 1922. From 1840 to 1905, when antitetanic serum was administered to only a few cases, the mortality rate was 76.4 per cent., whereas in 577 cases admitted from 1906 to 1922, inclusive, it was 67.4 per cent. Of this latter group only 273 patients were given antitetanic serum (average dose 13,000 units). From 1923 to 1929, the mortality rate decreased to 52 per cent. for 217 patients who were given moderately large doses of antitetanic serum (average dose 50,000 units). This decrease in mortality rate for the latter group is occasioned by a disproportionate decrease in the mortality rate in children.

From 1906 to 1922, inclusive, the mortality rate in 310 cases of tetanus which occurred in children under thirteen years of age was 65.8 per cent., or only 4.2 per cent. lower than for 286 adults during the same period. But from 1923 to 1929, inclusive, the child mortality rate in 113 cases was 41.5 per cent., whereas in 104 cases in adults it was 64.4 per cent. The average amount of antitetanic serum administered to adults was 52,400 and to children 48,000 units. These dosages at first seem disproportionate, but it is not the size of the patient but the amount of toxin in the blood-stream which should determine the dose.

Considering this marked decrease in the child mortality rate since moderately large doses of antitetanic serum have been used, it is apparent that adequate antitetanic serum therapy is of distinct value in the treatment of tetanus in children. Because there were only six deaths in the twenty-four cases in children which were given total doses of 40,000 to 60,000 units of serum, it seems that an initial dose of 40,000 units of serum should be adequate for the cure of many of the moderately severe cases in children.

In the adult cases the mortality rate was not greatly influenced by any particular amount of antitetanic serum administered, although the rate was only 33.3 per cent. for the nine cases which received more than 119,000 units of serum.

All cases in the recent series received antitetanic serum by the combined intramuscular and intravenous routes. Not infrequently the subcutaneous route was used in addition. The intraspinal route alone was not used in any case, but it was combined with other routes in thirteen cases, of which six died.

CONCLUSIONS

Wounds of the lower extremities cause more cases of tetanus than those of the other parts of the body, but the mortality rate is lowest in the cases developing from wounds of the lower extremities.

Of all common wounds in which tetanus developed those produced by nails were attended with the highest mortality rate.

Because of the many blank cartridge wounds resulting in tetanus with an associated mortality rate of 83.3 per cent. in this series, it is thought that such a needless and dangerous method of celebrating should be abolished.

Tetanus is a disease of the open season.

The lowest mortality rate in tetanus is for the cases which have incubation periods of from ten to twenty-one days.

Prophylactic doses of antitetanic serum lower the incidence of tetanus and lower the mortality rate in those that develop tetanus.

Because of the many cases that develop after long incubation periods, it is thought that wounds should be more skillfully attended to and that prophylactic doses of antitetanic serum should be repeated every seven days as long as there is a possibility that tetanus infection might develop.

Because of the marked difference in the mortality rates in children and adults in this series, one might be justified in concluding that antitetanic serum is of more therapeutic value in children than it is in adults.

An initial dose of 40,000 units of antitetanic serum is adequate for many of the moderately severe cases of tetanus in children, but because it is difficult to estimate the amount of toxin that is and will be in the blood-stream, and because all cases do not improve on 40,000 units of antitetanic serum, it is thought that all children who have not an obviously mild case of tetanus should receive, as early as possible, an initial dose of 80,000 units of antitetanic serum. Such a dose would frequently obviate the need for administering additional doses at a less favorable time.

In this series the mortality rate is high for adults receiving moderately large doses of antitetanic serum. The amount of serum used was often inadequate and was frequently administered too late. For these reasons, it is thought that massive initial doses should be administered as early as possible. Because the cost of massive doses is usually prohibitive ($3.50 per 10,000 units) a compromise of not less than 100,000 units of antitetanic serum is advocated as an initial dose for all adult cases of tetanus which are not obviously mild.

Even if symptomatic improvement occurs after the administration of large initial doses of antitetanic serum, it seems advisable to repeat doses

of 10,000 to 30,000 units of antitetanic serum for from three to five days or more.

If no symptomatic improvement follows the administration of large initial doses of serum, the patient should most certainly be given repeated doses of 50,000 to 100,000 units of antitetanic serum.

No conclusions can be drawn from the intraspinal administration of serum to patients in this series. However, the administration of antitetanic serum by the combined intravenous and intramuscular routes to children of this series has been attended by a mortality rate that compares favorably with any reported series. After a review of large series in the literature, it cannot be definitely concluded that administration of antitetanic serum intraspinally offers any advantage.

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OBSERVATIONS ON THE TREATMENT OF OSTEOMYELITIS BY THE "ORR" METHOD*

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During October, 1927, Dr. H. Winnett Orr reported a number of cases of osteomyelitis treated by a very radical method. The results, however, to those who have had the courage to carry out this type of treatment, have indeed been gratifying.

The first thought seems to be that one is deliberately sealing up an infected wound and after using the Carrel-Dakin method of treatment in acute osteomyelitis. To treat such a case, for example, of the tibia by the technic as described by Doctor Orr, and finally applying a plaster-of-Paris casing from the tip of the toes to the mid-thigh region, without even cutting a window, seems like a radical change in treatment.

The technic as outlined by Doctor Orr is, briefly:

(1) Make a fairly large incision over the infected bone area, spread apart the skin muscles, fasciæ, and the periosteum just far enough to afford access to the diseased area and no further.

(2) Chisel a window into the infected bone area large enough so that adequate drainage is provided, all dead bone may be removed, and there are no over-hanging edges of bone over the diseased area.

(3) Clean out the diseased area gently with a curette or gouge, being careful to refrain from unnecessarily damaging the tissues undergoing repair.

(4) Dry the wound, wipe out with 10 per cent. tincture of iodine, and follow with 95 per cent. alcohol.

(5) Pack the entire wound wide open but not tightly with sterile petrolatum gauze, cover with a sterile pad and bandage on.

(6) Perform any reasonable forcible manipulation necessary to place the parts in correct anatomic position for splinting.

(7) Apply a plaster bandage, preferably, or a suitable splint so that the parts are thoroughly immobilized in a comfortable and correct position.

(8) Finally, the case is not to be split, nor are windows to be cut until the wound dressing becomes necessary, and the wound is not to be dressed at all unless there is a rise of temperature or other signs of acute sepsis. As a rule, no dressing is necessary except on account of odor, and this may not be required for several weeks.

To compare any series of cases of osteomyelitis with any other series is difficult on account of the numerous factors involved, such as age of patient, bone site and portion of bone involved, type and virulence of invading organism, individual resistance and length of time the infection has existed.

This study was started in January, 1928, in Cooper Hospital, Camden, N. J., by Dr. B. F. Buzby and the author, and is based upon 100 unselected cases of acute and chronic osteomyelitis, and compound fractures treated

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by us, adhering rigidly to the technic as outlined by Doctor Orr. Prior to this time all cases of acute and chronic osteomyelitis and compound fractures had been treated by Dakinization.

Six deaths occurred in this series, all acute osteomyelitis in children in whom there had been considerable delay in the diagnosis of the condition and who were in very poor condition or moribund upon their time of admission to the hospital. All of these children showed a positive blood culture for the *staphylococcus albus*.

Of the deaths that occurred the distribution as to bone was as follows: one, radius; one, humerus; one, ulna; and three, femurs.

The series is subdivided as follows:

There were thirty-seven acute cases, fifty-seven chronic, and six compound fractures. The age incidence was from one to forty-seven years. The sexes were about equal, and every bone in the body is included in this series, the skull excepted.

The staphylococcus aureus and albus were the predominating organisms, and an occasional streptococcus hæmolyticus was found.

About seventy-five of these patients are clinically well. The remainder are still under treatment and a few of these are those types of patients who have had the disease from five to ten years.

These figures are believed to be those of the average hospital and are stated briefly to show the type of case which was being dealt with.

Acute Osteomyelitis.—Considering the acute types of osteomyelitis, with the exception of the six deaths reported, every patient was distinctly benefited by this operative procedure. They were usually free of pain on the day following operation and only in rare instances was it necessary to administer a sedative. The temperature range and pulse rate reached normal in an average of five days. It was not necessary to change any case earlier than three weeks; many were left six weeks, before the first dressing. The most striking fact during this period was the comfort of the patient, and as these patients are usually all children, one appreciates just what it means, not only to patient, but also to doctor and nurse, not to have to go through the ordeal of daily dressings.

Compare this method with Dakinization, or any other type of antiseptic treatment requiring frequent daily dressings, and it immediately becomes obvious that if for no other reason than the distinct comfort of the patient, this method is much to be preferred.

The guide as to the time for changing the dressing has been the odor. It is not felt that it is necessary to allow a plaster case to remain on until the odor becomes unbearable to the patient and his fellows. The average time for changing the case in these cases was from three to five weeks.

When the cases were opened, the wounds were found to be bathed in pus, the gauze extruded from the cavity and the entire space filled with healthy granulating tissue. Rigid aseptic technic was observed at the time of changing all cases. The wounds were protected with sterile drapes, were

then cleansed with alcohol sponges, and sterile petrolatum gauze repacked loosely into the cavity. Sterile dressings and plaster cases were then reapplied. In six patients, upon opening the case after an average of six weeks, it was found that the pus was no longer liquid, but of a consistency of cream-cheese, and that the wounds were practically entirely healed, and that no further inclusion in a plaster case was necessary, only a sterile dressing being applied. Of the acute cases the dressing or application of the plaster num-bered from one to five, with an average of three.

These patients were kept in bed for at least two weeks after the tempera-ture and pulse rate had reached a normal level, then were allowed to be up and about in a wheel-chair, keeping the affected part elevated. After the first dressing if the patients' general condition permitted and it was felt that they would be under competent medical supervision, they were allowed to return home, reporting to the hospital weekly, until it was time for a second dressing.

Chronic Osteomyelitis.—Practically the same procedure was followed in the treatment of the chronic types, operation being performed under tourniquet whenever possible. This undoubtedly saves considerable time and makes the procedure much easier.

Removal of sequestra, overhanging edges of bone and complete sauceriza-tion of the cavity was then done. The remainder of the technic was inden-tical with that of the acute types.

Many of these patients were sent home within a week or as soon as it was certain that the infection was quiet, reporting to the hospital weekly, or as often as it seemed necessary.

Practically all of these of the chronic type were completely healed after three dressings, a few after two dressings, and some with only one, the average being between two and three.

It was noted at the time of dressings that the defects had filled much more rapidly than in any other procedure previously employed.

Many of these patients had been operated upon before the institution of the Orr method, and had been treated by some type of daily antiseptic dressing and long hospitalization. Quite frequently these patients volunteered the information that they much preferred this type of treatment.

The question arises at this time, is it wise to immobilize the neighboring joints at this period of the disease? Will you get ankylosis and muscular atrophy? The answer is, that there has been no trouble with ankylosis in the adjacent joints; on the contrary there has been a surprising amount of motion immediately upon the removal of the plaster case.

As to muscular atrophy, that is always present to a more or less degree in every case of osteomyelitis. It is not felt that ankylosis will occur unless the adjacent joints are definitely involved by the infection.

Compound Fractures.—The compound fractures treated by this method were taken to the operating room immediately upon the admission of the patient to the hospital, providing, of course, that they were not greatly shocked.

They were cleansed with benzine, washed off with alcohol and swabbed with tincture of iodine. Small, loose fragments, destroyed tissue and any foreign material was removed, enlarging the wound if necessary. The wound was then packed loosely with petrolatum gauze and the part was placed in the best anatomical position possible, and whenever it was necessary to use mechanical extension, either by means of Steinman pin or ice tongs. The plaster case was applied with the extension on, the subsequent treatment being the same as that of osteomyelitis.

There are in this series only six cases of compound fractures. It must be admitted that we were reluctant to treat them by this method until we had had considerable experience in the treatment of osteomyelitis. There are at the present time about fourteen compound fractures that are progressing in a satisfactory manner, but not to be included in this report, because a sufficient time has not elapsed to be able to give a true end-result, but it is reasonable to assume that if the results continue to be as good in the future as in this small series, this will undoubtedly be the method of choice.

Of these six cases, five healed without any further treatment, one a very much comminuted gun-shot fracture of the middle of the shaft of the femur. A secondary operation for the removal of a small sequestra was necessary. These cases were about the worst possible types that one would see, so that it should be considered a fair test for the method.

As to defects following the extensive removal of bony tissue, it has not been necessary, thus far, to resort to any plastic procedure. There is only one case in the entire series in which it will have to be taken into consideration in the future.

Dr. Clay Rae Murray, of the Presbyterian Hospital, New York City, has done much experimental and research work pertaining to this point, and has shown definitely that before bone production takes place there must be a local concentration of calcium in the adjacent tissues. Accordingly, he has filled large bone cavities with calcium salts, and obtained excellent results. As yet, this work is unpublished.

The Bacteriology.—As previously stated, the predominating organisms in the cases of osteomyelitis were the staphylococcus albus and aureus. Cultures were taken at each successive dressing, and it was not unusual to find that occasionally they were sterile even on one occasion, as early as the first dressing. This phenomenon occurred five times during the entire series. The fact that one may occasionally obtain sterile cultures in infections of the staphylococcus type has been previously noted, and in relation to osteomyelitis. Albee has suggested that this may be due to a bacteriolytic substance, or the so-called bacteriophage generated within the wound itself.

Besredka and De Herrelle were the first to make and apply this substance to staphylococcic infections and have reported some excellent results. Rice, of this country, has pointed out that it fails to act in bone infections. Accordingly, Doctor Decker, who has been kind enough to give some assistance on

the bacteriology of these infections, has been able to isolate a bacteriolytic substance from the staphylococcus albus found in these infections.

As yet, we have not had sufficient time or experience to arrive at a definite conclusion. We hope to report on this point at a later date.

This is offered as one of the possible points which seem to influence a more rapid and complete healing by the Orr method.

Bone production and bone resorption show an extremely narrow margin. Where does the former stop and the latter begin? What factors control them? The pH of the blood and local tissues plays an important part. That bone production takes place in the presence of infection, there is no doubt. That there must be anœdematous infiltration for the multiplication of connective tissue, and the subsequent deposition of calcium into this new tissue, has been adequately established by Leriche and his co-workers. Is it wise, then, to wash away or destroy these vital elements of new bone production, with antiseptics, that never succeed in sterilizing the wound? These are offered as other points in favor of this method of treatment.

SUMMARY

(1) One hundred cases of acute and chronic osteomyelitis and compound fractures treated by the Orr method have been reviewed. No attempt at a definite comparative study with other methods has been made.

(2) The Orr method of treatment has proven very satisfactory and it is believed to be the method of choice in the treatment of osteomyelitis. It permits a'most certain individual attention which is not possible under the daily dressing routine.

(3) The time of wound healing is considerably shortened and the bony defects are less.

(4) The early or primary removal of as much diseased bone as possible lessens the amount of subsequent sequestration, and the number of secondary operations.

(5) The closed plaster bandage lessens the liability to secondary or mixed infection and does not in itself cause ankylosis of adjacent joints.

(6) From an economic standpoint the number of dressings and the time consumed are considerably less, nor is it necessary to hospitalize the patient the length of time needed for other types of treatment of this disease.

(7) Finally, it is far and away the most comfortable type of treatment from the standpoint of the patient.

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TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD MAY 5, 1930

The President, DR. GEORGE P. MULLER, in the Chair

CALVIN M. SMYTH, JR., M.D., Recorder

INTRAHEPATIC CHOLELITHIASES

DR. WILLIAM B. SWARTLEY reported the case of a man sixty-seven years of age, a painter, who was admitted to the medical ward of the Germantown Hospital August 22, 1929; complaining of pain in the right upper quadrant of the abdomen, jaundice, chills and fever.

He had had the usual diseases of childhood and gonorrhœa. He had never had typhoid fever. The family history was irrelevant.

Two days previous to admission to the hospital he had a mild pain in the right upper quadrant of the abdomen which became severe the next day, and radiated to the right scapular region. This pain was colicky in character and never entirely disappeared. The stools gradually became lighter in color and constipation was pronounced. The urine was highly colored. With the onset of these symptoms he had chills and fever. Previous to this attack, he was not constipated, but had difficulty in digesting fatty foods. Two years ago, he had an attack similar to this one except that the pain was not so pronounced. He did become jaundiced, however, but at that time, a diagnosis of lead poisoning was considered because of his occupation. There were no symptoms of peripheral nerve involvement or severe constipation. He has had a severe grade of pyorrhœa and much trouble with his teeth. Occasionally, he has had indigestion, belching of gas, and usually vomits during an attack of this nature. He has lost twenty pounds in weight during the past year.

When admitted, there was decided tenderness and rigidity of the right upper quadrant of the abdomen. The liver margin could be felt three fingers' breadth below the costal margin but the gall-bladder could not be palpated.

Five days after admission to the medical ward, the jaundice had considerably lessened and the patient was transferred to the surgical ward, but his improvement was so decided that he refused operation until September 12, 1929, when he had another acute attack of vomiting and pain with increased jaundice.

At operation, on September 25, the gall-bladder was found normal in size, not tense, walls thin, and it contained no stones. When passing deeper under the liver in the neighborhood of the porta hepatis (a "quarry" of stones was palpated. An incision was made into the duct containing these stones and sixteen large stones, three to ten millimetres in diameter, black in color and faceted, were removed. The incision into the hepatic duct was large enough to admit a finger so that the stones could be palpated. Most of them were in the hepatic duct, but a few were found in the common bile-duct. One stone, slightly smaller than the ones removed from the hepatic duct, was lodged high up in a duct in the liver; this could not be removed, but could be palpated. Because of the condition of the patient, it was decided that

further manipulation or destruction of tissue was not justifiable and the stone was allowed to remain. The liver was enlarged and showed evidence of hepatitis. The pancreas also was very hard throughout. The gall-bladder was then opened to make certain that there were no stones present. A rubber tube was sutured into the gall-bladder and a large rubber "T" tube was placed into the hepatic and common ducts for bile drainage and a cigarette drain deep into the transverse fissure and the abdomen closed.

Convalescence was normal. The drainage from the "T" tube was free. The tube in the gall-bladder was removed on the eleventh day. All jaundice had disappeared and on the twenty-eighth day the remaining tube in the hepatic and common ducts was clamped. No jaundice developed and the patient's appetite improved and he gained strength. On the fortieth day, the "T" tube was removed. There was very little bile drainage the next three or four days after the removal of the tube. Ten days after its removal, the wound was healed and the patient discharged, 11-14-29.

Lewisohn[1] states that at the time he wrote his article (May, 1916), "the surgical literature of intrahepatic calculi is a very small one; it comprises only two cases (Hawkes and Noguchi). Noguchi removed a solitary stone from a patient thirty-four years of age, from the hilus of the liver. The stone had a diameter of one and one-half centimetres. Noguchi reports that the exposure of the operation field was by no means satisfactory. It may be doubted whether Noguchi's interpretation of his case (solitary intrahepatic stone) is a correct one. It is very possible that he was dealing with a solitary stone in the cystic duct which had perforated into the surrounding tissue, where it became encapsulated. The gall-bladder was not removed in this case."

In Doctor Swartley's case, the gall-bladder contained no stones and was normal in every respect to gross examination, and, therefore, no adhesions binding it to the quarry of stones under the liver. These stones were removed by opening the bile-duct proximal to the cystic duct (easily located) that is the hepatic duct. Since this quarry of stones was located in the hepatic duct just outside the porta hepatis, and one at least could be felt higher in the liver bile-ducts, waiting to drop down into the quarry with the others, one naturally would think the liver to be the source of origin in this case. The reporter remarked that there may be hundreds more above the one that he palpated and could not remove, as there was in a case that was operated upon by the late Dr. Francis T. Stewart, which case he did not report. His case was operated upon three times for gall-stones. After the third operation, in the Germantown Hospital, the patient died. It was the speaker's duty to perform an autopsy on this patient.

At his operation, the common and hepatic ducts were filled with a material of a putty-like consistency which was removed. At the autopsy the bile-ducts were opened from the transverse fissure throughout their entire extent to the very thin margins of the liver, and gall-stones were found in great numbers, larger toward the central main duct and gradually graded smaller toward the periphery like a string of beads. Lenhartz had just this type of

case. Lewisohn shows the picture of the liver of Lenhartz's case in his article.

Since Doctor Swartley's patient left the hospital he has had no jaundice, pain in the abdomen nor chills and fever. Even though we know he had a stone retained in the liver, it could have passed down into the hepatic duct and out through our "T" tube drainage. However, no such stone was found in the bile drainage receptacles or on the dressings after the operation. In Judd and Burden's case,[2] they mention that their patient had no clinical evidence of a stone in the liver. In the case now reported there may have been only this one or he may have had hundreds more. With the view of determining this possibly by X-ray, an X-ray was made May 1, 1930. There was a shadow shown in the area of the porta hepatis which the radiologist, however, would not definitely interpret as a stone.

BEER, LEWISOHN, ERDMANN, and JUDD have all written interesting articles on Intrahepatic Cholelithiasis.

BEER, in 1904 (Med. News, vol. lxxxv, 1904), studied this condition most thoroughly by dissecting 250 livers of patients who had died of gall-stone disease and found gall-stones in the hepatic ducts within the liver in six cases (2.5 per cent.). He has given three different causes for their formation: first, obstruction; second, cholangitis; and third, an unknown factor (diathesis?).

LEWISOHN, in 1916 (op. cit.), was induced to report his case because of (1) the extreme rarity of the condition in surgical pathology; (2) the fact that his case was the first case in which intrahepatic stones had perforated, thus causing a localized peritonitis; (3) the interesting observation that a biliary fistula which persisted for eight months, closed spontaneously (and has remained closed for four months), though the hepatic ducts, and very probably the common duct, are filled with stones.

J. F. ERDMANN, in 1918 (International Clinics, vol. 28, pp. 111, 131, 1918) in his article speaks of these cases as the "bête noir" of the surgeon. The first man goes in and removes a handful or more of gall-stones, the symptoms return and the patient consults another surgeon. He operates and removes the gall-bladder, and says, "Now this patient can have no more gall-stones, for the gall-bladder has been removed." But he forgets the intrahepatic passages. The stone-producer may be present in the small branches of the biliary system, due to the staphylococcus, the streptococcus or the colon bacillus, etc., and this may give trouble even twenty-five years after an operation has been performed and the gall-bladder removed. In an intrahepatic case, there is no question that the stones may come down at successive times and one cannot guarantee to relieve the patient permanently by one operation, but in 92 to 95 per cent. of the cases, there is no recurrence, while in the remaining 5 to 8 per cent. we must expect to get a recurrence.

JUDD and BURDEN, in 1926, reported a case in which they state that the unique features which form the subject of their report are: "The finding of many large intrahepatic calculi in a liver which was grossly normal, more than eleven years after cholecystectomy; and removal of numerous stones from the extrahepatic ducts; and the presence of this condition without the occurrence of jaundice or any clinical evidence of hepatic insufficiency, the condition being an incidental finding in a patient who died from intestinal obstruction."

REMOVAL OF RUBBER TUBE FROM COMMON BILE-DUCT

DR. EDWARD J. KLOPP reported the removal of twenty-six centimetres of a No. 24 soft rubber catheter which had been used, after the method of Duval and Richard, in repairing a stricture of the common bile-duct on April 12, 1926, and presented at a meeting of the Academy held February 7, 1927. The man was aged thirty-six at the time of that operation and had many attacks of abdominal discomfort, gaseous eructations and constipation but was able to work as a clerk.

In April, 1929, the abdominal discomfort increased, the "gas would move from place to place." He was obliged to use laxatives and enemas about every three days. A gastro-intestinal X-ray with a barium meal failed to reveal any evidence of obstruction. In February, 1930, the discomfort became more marked. There was constant pain above the umbilicus. He became slightly jaundiced and was admitted to the Pennsylvania Hospital February 24. His stools were clay-colored and there was itching of the skin. Another gastro-intestinal X-ray showed no evidence of obstruction. The stomach emptied in two and one-half hours.

March 7, 1930, the tube was removed under spinal anæsthesia. There seemed to be fewer adhesions than at the two previous operations. The tube was easily felt in the duodenum, also in the common bile-duct. An attempt was made to dislodge the tube by gentle manipulation of the duodenum. This was unsuccessful. The duodenum was then opened and the tube removed without much resistance. Bile promptly appeared in the duodenum. The common-duct area was palpated (but not probed) for evidence of stone; none could be demonstrated. The hepatic ducts were so buried in adhesions that identification was out of question. The duodenum was closed with two rows of catgut sutures. The suture line was reinforced with omentum.

Two days after the operation there was evidence of peritonitis, resulting in death on the fourth day.

The tube removed was described by the pathologist, Dr. I. J. Wolman, as follows:

"The specimen is a piece of rubber tubing measuring twenty-six centimetres in length and one centimetre in diameter. It is somewhat curved in shape but its ends project straight outward. One end for a distance of six centimetres is crusted with a dry, orange-yellow deposit, not very abundant, but enough to cover the surface. This end has a funnel-shaped dilatation with a diameter of 1.3 centimetres. The remainder of the tube is dark green on the surface, through which the underlying red rubber shows through little cracks. In opening the tube it is found that the gall-bladder end is filled with granular, friable yellow deposit similar to the incrustation on the surface. The deposit has apparently completely blocked the terminal dilatation and almost completely fills the lumen for six centimetres. Beyond that there is a less abundant yellowish-green deposit on the inner surface which extends for the remaining entire length of the tube with the exception of the terminal seven centimetres. The rubber still retains a little of its elasticity. It is red in color. The line of demarcation between the superficial crust at the end which was located at the side of the gall-bladder and bile-ducts and the distal green color, is abrupt and at the site of transition the tube appears a little constricted for a length of one centimetre proximal to the transition."

Autopsy revealed a moderate amount of bile-stained, purulent fluid. There was an abundant yellowish exudate about the suture line of the duodenum, but no defect was demonstrable.

The points of note were that the liver was slightly enlarged; the larger ducts were dilated and contained numerous, irregular, granular concretions; eight of these were .5 centimetre in diameter. There was a soft stone two

centimetres in diameter at the junction of the hepatic ducts, and one, half that size, above in the right hepatic duct.

The common duct was dilated with a diameter of about 1.2 centimetre, wall was thickened, fibrous, and the inner surface was congested and dull in appearance. Five centimetres from the ampulla of Vater on the inner aspect there was a small ulcer-like defect (absence of mucous membrane) three centimetres in diameter. The edges were indurated. Bands of scar tissue were visible radiating out in all directions from its margin. There was a small opening through which a probe could be passed, permitting the escape of bile.

The reporter thought it was a mistake to use a catheter of such large size. There had been two previous attempts to relieve the stricture, one by himself. He was especially eager to prevent another failure. A second error was that the catheter should have been removed long before. One should anticipate the formation of stones. He questioned whether the catheter should have been permitted to remain more than twelve or eighteen months.

Dr. George P. Muller said that he agreed with Doctor Klopp that it is not a wise procedure to attempt to implant a "T" tube when dealing with the stricture of the common duct. The strictured part seems to extend right to the end of the duodenum. After exposing the area of stricture, it is better to pause a moment to decide what to do and an immediate hepatico-duodenostomy will often give the best result. He has had four this year. He also thought the point was well taken regarding the use of a tube sufficiently small so that it will be easily swept on into the duodenum.

FOREIGN BODY IN HEART

Dr. J. R. Veal, by invitation, presented a man, thirty-nine years of age, who was admitted to Doctor Mitchell's service at the Pennsylvania Hospital at 9:10 A.M., April 26, 1930, with a history that twenty minutes previously he had been struck over the heart by a block of wood thrown by a circular saw.

On admission, patient was cold and clammy, blood-pressure 54/40, pulse 96, poor volume but regular. Over pericardium in the third interspace, just above and to the inside of the left nipple, there was a small, apparently superficial laceration which had bled slightly. Careful examination of the thoracic wall revealed no signs of injury to ribs or sternum. The heart was in normal position; was not enlarged to percussion; the sounds were very weak and distant; rate 96; rhythm regular; no murmurs or adventitious signs were noted. There was definite restriction of expansion in the left lower chest, breath sounds were weak and distant in this area. No râles were noted. Respiration 28. Chest otherwise negative. Abdomen was rigid especially in the upper left quadrant. There were no signs of contusion or external injury to abdominal wall. No shifting dulness in flanks. Physical examination was otherwise negative.

Under treatment the patient gradually improved, his blood-pressure rose to 96/70. He complained bitterly of pain in epigastrium and upper left quadrant. His heart rate remained around 90. He vomited several times, the vomitus containing no blood. Throughout the day the patient continued in this condition. On the following day, at 9:30 A.M., twenty-four hours after accident, blood-pressure was 90/60, pulse 110, temperature 100°, and he continued to complain of intense pain in upper left abdomen. The abdom-

inal rigidity was less marked, and there was no further evidence of injury to any other abdominal organ. The patient was incontinent. There was no bleeding from laceration noted above. The heart rate was 110, sounds weak, poor quality, rhythm regular. The heart was in normal position and not enlarged to percussion. There was a slight impairment over left lower chest with a few crackling inspiratory râles.

At 9 P.M. on this same day the patient's temperature rose to 104, pulse 120 and he became very restless and had to be restrained in bed. His pain continued as above, morphine and sedatives having little effect upon it. At this time the left lower chest revealed signs of consolidation. The heart borders could not be outlined but seemed to merge with the dulness in the left lower chest. The patient soon went into shock again and his condition gradually grew worse. Heart rate was 130, sounds very weak, rhythm regular, pulse imperceptible. Both lungs were filled with bubbling râles and

FIG 1 —Anterior surface, showing heart and lungs, with splinter piercing heart

respiration became quite rapid. Patient died at 6:30 A.M., April 28, forty-six hours after initial injury.

Post-mortem examination —The body is that of a muscular male, estimated to weigh 160 pounds. It appears normal externally except for a small skin lesion located 1.5 centimetres medially and slightly cephalad to the left nipple. This lesion has an area measuring 8 by .6 centimetre. It is brown and dry and appears as if pressure atrophy of the skin had occurred There is no evidence of perforation but probe can be passed through it into the underlying tissues.

The left lung is collapsed and the pleural sac filled with 2000 cubic centimetres of dark red blood, partially clotted. There is a small perforation 0.5 centimetre in diameter in the parietal pericardium, beneath the superficial skin lesion. The pericardial sac is filled with clotted blood. There is also a dull fibrinous exudate on the surface everywhere. Projecting upwards from the anterior surface of the heart from the middle of the left ventricle is a blood-stained splinter of wood. (Figs 1 and 2) The splinter measures nine centimetres in length and is pyramidal in shape, its base being about one centimetre square Its sides are irregular and grooved. The point is fairly sharp The splinter has entered the heart through the left ventricle wall on the anterior surface. When removed the wound gaps open and blood flows from the heart. The splinter has

perforated the heart and a few millimetres of its tip appears on the posterior aspect of the left ventricle. The heart itself is contracted and not hypertrophied. The great vessels seem normal. It is not opened but perserved intact as a museum specimen. The left lung is somewhat collapsed. The right lung is somewhat voluminous. No consolidation is found anywhere. There is no blood in the right pleural cavity and no exudate on the surface.

FIG. 2.—Showing length and size of splinter with portion of skin showing where splinter entered the chest wall—nipple, etc.

CHOLECYSTOSTOMY

DR. BRUCE L. FLEMING, by invitation, read a paper entitled "An Investigation of the Functions and Symptoms of the Surgically Drained Gallbladder."

LYMPH EXUDATE AND FIBROUS TISSUE

DR. EDWARD T. CROSSAN pronounced the annual oration on the above-titled subject for which see page 1019.

STATED MEETING HELD OCTOBER 6, 1930

The President, DR. GEORGE P. MULLER in the Chair

NECROSIS OF BONES OF FOREARM FOLLOWING TRAUMATIC REMOVAL OF PERIOSTEUM

DR. GEORGE M. DORRANCE reported the case of a man admitted to St. Agnes' Hospital, September 4, 1928. The forearm had been injured in a wringer. A large amount of muscle, tendon and fascia had been torn away

from the anterior and posterior surface. The periosteum seemed to be denuded from the area that subsequently sequestrated. The wound became infected and was treated by Dakin's oil. An X-ray plate taken September 11, 1929, showed the bones of the forearm and wrist normal. Three weeks later another series of plates showed an area of beginning necrosis. On December 14 the X-ray plates showed a free sequestrum in each bone (Fig. 1). By January 17, 1930, the X-ray showed the ends of the bone had approximated each other and union was taking place between the end of the radius and between the two lower ends of the radius and ulna. The speaker remarked that if the whole end of the bone had become necrotic, he could understand that the circulation to the bone marrow had become obstructed. However, it
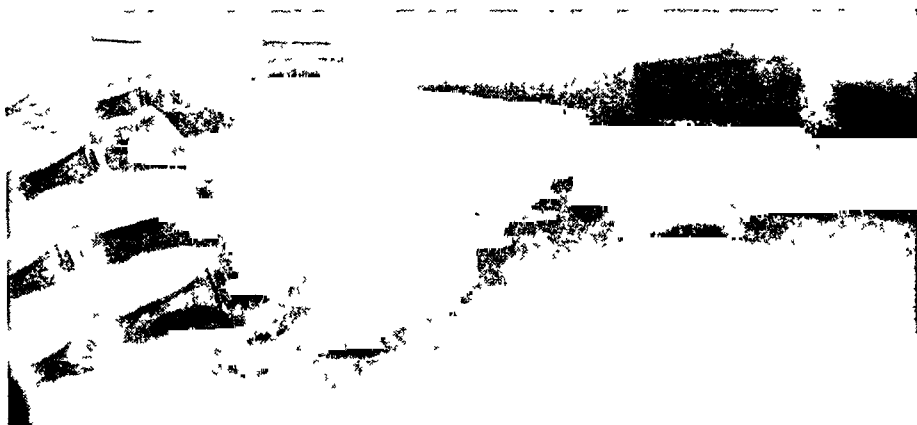
FIG. 1.—Post-traumatic necrosis of radius and ulnar. Condition three months after injury.

was difficult to explain the localized necrosis unless they were dealing with injury to the overlying periosteum followed by secondary infection.

BLASTOMYCETIC OSTEOMYELITIS OF FEMUR

DR. BENJAMIN F. BUZBY reported the case of a boy, aged eleven years, who was admitted in the Orthopædic Service of Cooper Hospital November 7, 1927, with the complaint of swelling of the left thigh, pain in the left hip on motion, on walking, and on exposure to cold.

The family history was negative. His own health had always been good.

He dated his present disability to a fall he had had two and a half years before when he injured his left thigh. He recovered from this in a short while and was free from symptoms except aching in damp weather until two weeks before admission, when he noticed swelling of his left thigh and pain on use.

Examination showed him to be a fairly well-nourished boy in no apparent discomfort. His temperature was 99.4°, pulse 120, and respirations 24. There was a slight enlargement of the heart with a presystolic thrill and a low-pitched presystolic mitral stenotic murmur with accentuation of the pulmonic second sound. Except for the condition of his left thigh his examination otherwise was negative. His left thigh was considerably enlarged in its upper third where there was localized heat, redness, and induration over a small area on the antero-lateral aspect. The skin was freely movable over this mass, and the mass seemed unattached to the underlying bone. There was no fluctuation. The blood count was: erythrocytes, 4,790,000; hæmoglobin, 80 per cent.; leucocytes, 13,100 with 71 per cent. polymorphonuclears, 26 per cent. lymphocytes, 1 per cent. large mononuclears, and 2 per cent. transitionals. The urine was negative. The Wassermann was negative. November 8, 1927,

an attempt was made to aspirate this mass but only a few drops of blood were obtained which gave a sterile culture. November 8 his white blood count was 10,200. November 14 an exploratory operation was done. When the periosteum was incised and elevated much necrotic material and some pus were evacuated. The patient's condition became alarming when the bone was exposed and the wound was packed with gauze and the operation stopped. Culture from under the periosteum showed staphylococcus albus. Tissue removed at the same time, when examined microscopically, was infiltrated with pus, lymphocytes and other exudative cells. For the next three days his temperature averaged about 100°, but his pulse, which was 176 at the cessation of the operation, returned to 126 within twenty-four hours. Two days later,
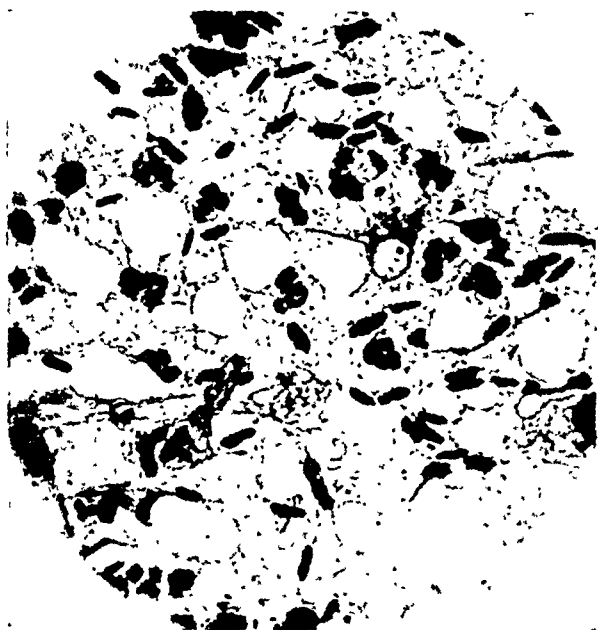
FIG. 2.—Smear showing pus cells and cigar-shaped spores, obtained at primary operation.
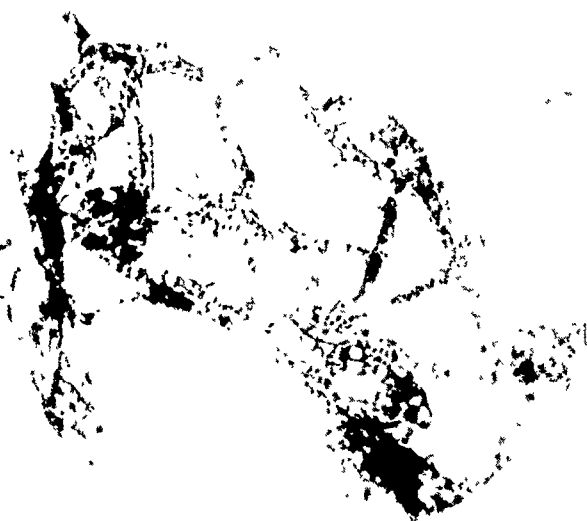
FIG. 3.—Smear showing typical growth of organism, obtained from culture.

under anæsthesia, the packing previously placed was removed, and a typical saucerizing operation was done, after removal of all the necrotic tissue. No sequestrum was found. The wound was packed with gauze and a dry dressing applied. There was an excessive amount of post-operative oozing which continued for several days. His temperature by now was normal, pulse 110. The bleeding was controlled by packing by this time and his blood count, under liver diet, hæmatinics and high caloric diet, improved constantly. Much difficulty was encountered in getting a donor so no transfusion could be given early, but December 13 a transfusion of 300 cubic centimetres of whole blood was given. He was discharged from the hospital January 8, 1928, with his wound healing well by granulation, feeling quite fit and with a normal blood count.

The boy did well until about August 1, 1928, when he noticed a small, tender swelling in the popliteal space. This gradually became larger, until on readmission to the hospital on August 19 there was a tender swelling filling the left popliteal space which was constantly aching on use, but with no limitation of function of the knee. There was slight increase in circumference on the affected side. The temperature was normal, pulse 100, and respiration 20. The urine was negative and the blood count showed a slight secondary anæmia. Former X-ray had shown thickening of the femoral shaft only, but now there were two cavities, each 1 centimetre in diameter, presenting about 6 centimetres above the intercondylar notch. The abscess was evacuated and the affected bone area saucerized. The pus resembled staphylococcic pus in

appearance. No sequestra were encountered. The wound was treated by the Orr technic for osteomyelitis with a plaster bandage applied from the toes to the upper thigh. The smear from this pus showed many pus cells and many cigar-shaped, large, spore-like bodies, but no pyogenic bacteria. The culture report, when finally submitted by Dr. F. L. Weidmann, from the University Laboratories of Dermatological Research, who had been working on it in conjunction with Dr. D. L. Farley, read in part, "This is a strange yeast to me. It appears to belong to the Monilias and is probably a valid pathogen according to the clinical pathological circumstances in the case, but we have run into a very common experience in fungus work, namely, fungi can only successfully invade tissue where receptivity is just right on the part of the host." This report was made after repeated animal inoculation and growth on various types of culture media. It is interesting to note that at the first changing of the plaster case an attempt was made to obtain the same growth from the uncontaminated wound but this culture was sterile and direct smear showed only pus cells.

Convalescence from this operation was uncomplicated and he was discharged from the hospital on September 20 with a plaster case from his toes to his upper thigh and walking with crutches. His upper thigh wound was healed at this time and the lower wound progressing satisfactorily. On December 4 a caliper walking brace was applied and weight bearing with crutches permitted.

On December 27 he was readmitted to the hospital with an area of redness presenting on the inner aspect of the lower thigh which was hot and tender but showed no fluctuation. At operation no pus was encountered and no culture taken but upon cutting through the periosteum and stripping it back it was found that a superficial layer of cortex was adherent to the periosteum and came away with it leaving a comparatively smooth non-bleeding surface. These fragments were carefully removed and the wound packed with vaseline gauze and, after exploring the popliteal wound and removing from it a small fragment of necrotic bone, a plaster splint was applied. There was quite a sharp post-operative reaction with pulse up to 160 and temperature to 103° but the pulse was 100 and temperature normal within a week. The splint and packing were removed on January 7, 1929, and his brace reapplied. He was discharged from the hospital in excellent condition, following which time this wound rapidly closed in and he has had no further symptoms in his thigh and has retained full function of his knee-joint.

He was readmitted to the hospital on July 24, 1929, with involvement of the lower end of the tibia. This area was opened and saucerized according to the Orr technic and a plaster case applied. A culture from this abscess showed staphylococcus albus.

He has had a persistent sinus in the popliteal space, the area from which this yeast organism was primarily obtained, but the amount of discharge has been only slight and serous in character in large part.

DOCTOR BUZBY remarked that the literature on blastomycetic osteomyelitis is scanty with practically all the cases reported being fatal, the osteomyelitis being a part of the general systemic infection in which the lung, skin and bone are the commonly involved structures with the spleen, kidney, liver, lymphnodes and brain following in that order of frequency according to the report of Wade and Bel in twenty-two autopsied cases. They note that small abscesses are found in the liver and spleen while large ones invade the joint and cause secondary erosion and caries of bone.

Dickson's case was secondary to a pulmonary infection and the patient died in a few months from multiple generalized abscesses following a course of general pyæmia, the bone abscesses having been continuous with the soft tissue or lung collections of pus.

Wrede maintains that all bone abscesses are not metastatic but arise by continuity of infection and contiguity of structures and the bones most commonly affected are those near the respiratory and alimentary systems, as the blastomycetic infection enters the blood-stream through these portals and not through the skin. He further believes that when the process begins in the skin it extends to the periosteum and then on into the medulla, showing first peripheral caries. Respiratory system infection leads eventually, however, to metastatic infection.

Ryerson's cases were systemic and pulmonary in origin, were fatal and both resembled multiple tuberculous abscesses.

Connor's report is mainly a bacteriological one but his patient had a lesion of the humerus with many sinuses about the elbow, and a lesion of the os innominatum with abscesses on the buttocks. The patient was in apparent good health with no fever or leucocytosis. He also fails to place the causative organism in a definite classification due to its changing characteristics in culture media. The outcome of this one is not stated.

Chifalieus' case closely resembles the one here reported in that it was in a woman, aged twenty-five, who had been ailing for four years before admission with swelling, redness over the lower femur and limitation of motion in the knee. Her primary diagnosis had been tuberculosis or chronic osteomyelitis. At operation there was found a gelatinous albuminous exudate about white non-bleeding bone with a large single cavity in the lower end of the femur. The bone was treated by washing with ether and packing with gauze. The patient recovered fully but had a serous discharge from an overlying sinus lasting several months. This was thought to be secondary to a vesicant applied to the chest wall four years before symptoms began and eight years before adequate treatment was instituted.

In looking backward over the case herein presented several features make it appear quite different from ordinary chronic osteomyelitis, of which this boy has had two apparent attacks, the upper femur and the opposite tibia, from both of which staphylococcus albus in pure culture was isolated.

1. Low white blood cell count—7,400 when the Monilia was the causative agent as against 13,100 when the staphylococcus was isolated.

2. Low temperature and rapid pulse.

3. Superficial dry necrosis of the cortical bone with lamination of the subperiosteal layers of bone.

4. The generalized thickening of the femoral shaft without history of serious preceding or accompanying symptoms until abscess formation became apparent.

From his continuous appearance of good health surely a source of infection in the lung or gastro-intestinal tract can be ruled out, which would leave either his chronic facial eczema or less likely the slow-healing gunshot wound of his palm as the portal of entry of the yeast infection. Even thus it is hard to explain the two different types of organisms found in the three separate bone abscesses. The infection must have been hæmatogenous in

origin with the primary focus long since entirely obliterated, for he never had an overlying skin lesion.

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TREATMENT OF OSTEOMYELITIS

Dr. Irvin E. Deibert, by invitation, read a paper entitled "Observations on the Treatment of Osteomyelitis by the Orr Method" for which see page 1087.

Dr. Eldridge L. Eliason said that Doctor Orr has placed emphasis on two or three points; one is proper drainage, the other is rest, and that rest means rest by splinting and rest from the over-zealous dresser. Most surgeons seem to have come to the conclusion that acute osteomyelitis is no longer a subject for a long incision and canalization the full length of the bone and a curette, scraping out all the medullary cavity after having pushed back the periosteum to its full extent and thereby exposing raw bone for infection. Today the consensus of opinion is that acute osteomyelitis is best treated by as small and adequate an incision as can be accomplished for the purpose of drainage, which is a point the author brought out by the Orr treatment. This can be accomplished by a small incision and a drill or burr hole in the bone in the desperately sick patients. The crux of the matter is—does the Orr method deliver lower mortality and morbidity? The mortality of acute osteomyelitis is higher than it should be. Mormier in 779 cases and Lewis, of Baltimore, in 260 cases, have found the mortality between 15 and 17 per cent. In the whole series, acute and chronic, it was somewhere between 4.5 and 5 per cent. They also have shown in the vast majority of cases of acute osteomyelitis, that the patients reach the hospital after the disease is four to seven days old. Therefore, the disease has progressed and in very many instances has become, or at least is, at the time of admission, a blood-stream infection. Therefore, the early diagnosis based upon point tenderness and the advantages offered by the Orr treatment should help us to improve the mortality and morbidity in the acute cases. Doctor Deibert spoke of the daily dressings of the wounds treated by dakinization; he probably means frequent. Furthermore, most of us, although we may not follow the Orr technic absolutely, at least approximate it by the use of paraffin mesh and vaseline gauze, loose dressings in the wound, and the dressing of the cases after allowing them to go five to six days after operation. Doctor Eliason has had no experi-

ence in treating open compound fractures by the Orr method, but thinks if it applies in the other instances it might apply to them also.

Dr. Calvin M. Smyth, Jr., said that in the past year he had treated fourteen cases of open fracture by this method; twelve fractures of the leg, one of the femur, and one of the forearm. In no instance has he had cause to regret employing the method. The objectionable odor in osteomyelitis cases is not often encountered in the fracture cases, unless a good deal of infection had taken place. He feels that probably a little too much emphasis has been placed on vaselinized gauze and that possibly some other things would do just as well, iodoform, for instance, or gauze saturated with dichloramine-T.

He usually removes the case at the end of four weeks because after doing a few of these operations he found the gauze was extruded from the wound by granulation at that time and one usually found a clean, red, granulating wound that required no further packing. In these fourteen cases it had not been found necessary to open the enveloping bandage, and the results had been uniformly good. A very important point in treating fractures by this method is to recognize anaërobic infection and to deal with it should it occur.

Dr. B. F. Buzby stressed the necessity of complete removal of overhanging bone and all necrotic bone, and in acute osteomyelitis the question is getting patients to the hospital sooner. In the past year, on each of three successive Saturdays, three late osteomyelitis cases were admitted to the speaker's service, two of the femur and one of the radius. In one instance the patient had been sick for three weeks, another two and a half weeks, and one of the femur, sick one month, he thought was going to die on the table. This child disappeared at the beginning of the summer and reported back at the end of the summer with function practically normal in knee and hip. In the question of drill hole and the burr hole, Doctor Buzby took issue with Doctor Eliason because during the time covered by this series he has done them both ways and he has had more secondary sequestrectomies from the drill hole, while he has had none from primary removal of overlying cortex by a chisel. With drill holes, burr holes or trephine, the edges of the bone have died, possibly from the heat of the drill, and secondary operations have had to be done.

Dr. DeForrest Willard said that patients treated by the Orr method are more comfortable than others, and this is one of the great advantages of the method. He thought if the patients in the same ward were deprived of the sense of smell they would all be more comfortable. The odor, as the case gets older, is something beyond belief. If one made the first dressing in two weeks as Orr first advocated, one could do away with the objectionable features of this treatment and give the patient a very thorough method of treatment with a minimum of pain during convalescence.

Dr. Lee A. Rademaker said that studies regarding bacteriophage might have a practical application in connection with the method of treatment under discussion. Every organism has a certain amount of bacteriophage which can be brought into usability by certain procedures. It is interesting to

speculate upon the question as to whether, in a localized infection in which constant drainage is allowed to take place, the phage acts to destroy the infecting organism. In two cases of osteomyelitis treated by Doctor Muller and the speaker, bacteriophage was deliberately introduced into the wound and it showed rapid improvement. Doctor Rademaker mentioned this merely as a possible explanation of the good results obtained by what on first glance would appear to be an unreasonable surgical procedure.

CORDOTOMY FOR THE RELIEF OF PAIN

Dr. Francis C. Grant read a paper with the above title for which see page 998.

Dr. Charles H. Frazier remarked that there is no question but to Doctor Spiller belongs the credit for conceiving this method of controlling pain in the trunk and lower extremities, no matter what its source. Though founded on sound physiological and anatomical facts and though on many occasions clinical demonstrations of its effectiveness have been made, practitioners generally are uninformed as to the possibilities of cordotomy. Inoperable pelvic carcinoma is one of the common causes of intractable pain and the speaker ventured to say of the specialists in urology and gynæcology that few know what relief the operation would afford their patients.

The indication for the operation is clear enough—insufferable pain—but it is well to keep the patient under observation a few days in order to make sure that the pain is intense enough to justify a formidable operation.

From his own experience he is convinced that cordotomy is the most humane of all operations. Morphine is not the solution of the situation. Ever-increasing doses eventually fail to give relief, digestion is upset, sleep impossible and the patient generally demoralized. He remembers so well the comment of a patient after the operation, with an expectation of life of not over six months, "This is heaven."

As with all new operations, the technic will be modified from time to time. Originally Doctor Frazier designed special hooks to guide the operator in determining how deep to cut. These hooks are still useful in fixing the cord as the section is made, but since he has been making the section with the patient conscious, the depth of section can be determined by testing the patient. And he has found it an excellent plan to give the patient a rehearsal for several days prior to the operation of how he shall be expected to respond when tested for pain and temperature sense. Too much stress cannot be laid on this innovation. By cutting cautiously from without inwards in the conscious patient one can cut the tracts for tactile and conserve those for temperature sense. This is a delicate refinement that was not contemplated in the early days of the operation.

There is no doubt the operation has come to stay and should be given greater publicity. It is practised all too seldom. To be able to relieve pain of such intensity without damage to the other cord tracts is a real surgical accomplishment.

BRIEF COMMUNICATIONS

A MUSCLE-SPLITTING INCISION FOR POSTERIOR RESECTION OF THE UPPER THREE RIBS

A MUSCLE-SPLITTING incision for the posterior resection of the upper three ribs is described. It extends from the first dorsal spine to approximately the mid-portion of the spine of the scapula. The fibres of the trapezius muscle are separated and retracted, thus exposing the superior rhomboid and levator scapulæ muscles. These muscles are separated and retracted, giving an excellent exposure of the upper two ribs so that as great a length of these
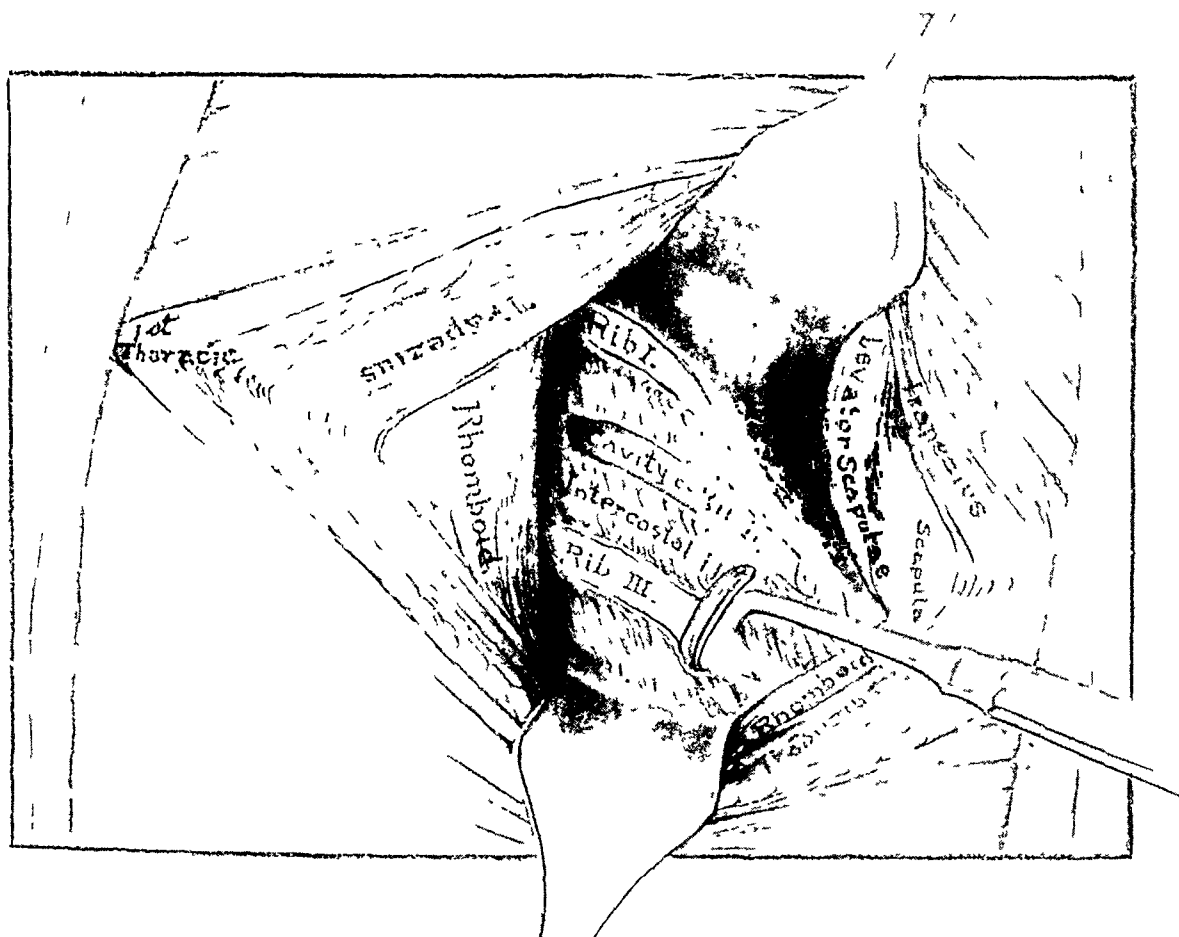
FIG. 1.—Incision for exposure of the upper three ribs, showing separation of the levator scapulæ and superior rhomboid muscles.

ribs as desired can be removed. The exposure of the third rib is less adequate but sufficient to allow it to be resected lateral to its angle. An additional segment can easily be removed from this rib at the second stage. There is usually little blood lost in the operation and the nerve to the superior rhomboid muscle is easily preserved.

This incision was first used in April, 1928, and has been used in eleven cases since that time. It has been used only in cases which were considered poor surgical risks, where resection of more than three ribs at the first stage

was considered unwise. Section of the heavy muscles over the upper portion of the shoulder with the resulting hæmorrhage and post-operative discomfort is avoided.

Head[1] has described an incision which differs from this one only in that he separates the fibres of the superior rhomboid instead of going between the superior rhomboid and levator scapulæ. Since the superior rhomboid is a short muscle, the exposure obtained by separating its fibres is quite limited. By going between the two muscles a better exposure of the first two ribs can be obtained.

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TRAUMATIC INGUINAL HERNIA *

TRUE traumatic hernia is very rare and only a few cases have been reported in the literature. This hernia is due to an injury that tears the tissues, either by a crushing blow, a fall from a height or a laceration of the structures by a sharp instrument.

Z. O., a white male of nineteen, a chauffeur by occupation, was admitted to the Fourth Surgical Service of Bellevue Hospital September 15, 1929, suffering from pain and swelling in the right groin. The same day while riding a motorcycle he had been struck by an automobile and thrown about five feet, striking his right groin against the handlebar. Past history was negative. He had never been injured in any way nor had he had any complaint relative to the right groin.

Physical examination showed a well-developed, well-nourished, young adult male. Examination was negative except for the right groin where there were pain and tenderness on slight pressure; there were redness and a slight bulging of the right groin over the internal inguinal ring, with muscular spasm. The bulge increased on coughing.

A diagnosis of right indirect inguinal hernia of the occupational, industrial, or accidental type was made, it being thought that the hernial sac was present from birth and made evident by the motorcycle accident. An icebag was applied to the right groin and the patient confined to bed for three days. At that time there were no skin redness, no break in the skin surface, and no pain.

On September 18, 1929, he was operated upon for inguinal hernia under spinal anæsthesia. The operation chart reads as follows:

The customary inguinal incision was made. On reaching the aponeurosis of the external oblique muscle, the aponeurosis was found to be split through the external ring parallel to the fibres and running obliquely lateral for five inches over the internal ring. The split was traumatic and not congenital. There was considerable free serum and blood. At the internal ring there was a two-inch transverse tear of the internal oblique and transversalis muscles, the ring thus being destroyed. At the internal ring lateral to the inferior epigastric artery was a bulge of peritoneum more marked when the patient coughed. The cremasteric fascia was incised and no evidence of an indirect hernial sac

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[1] Arch. Surg., vol. xvi, p. 1075, May, 1928.

* Read before the Surgical Section of the New York Academy of Medicine, April 4, 1930.

found. The hernial sac was not opened. The lacerated muscles were sutured with No. 2 chromic catgut, the cord transplanted and a typical Bassini repair performed using No. 2 chromic catgut double continuous. Black silk to the skin. No drainage. The patient made an uneventful recovery and was discharged on the thirteenth post-operative day. Fortunately, no infection occurred in the traumatized tissues. He has been seen twice since discharge and shows no evidence of hernia and is symptom-free.

A traumatic hernia is subject to the following conditions:

(1) The relationship between the accident and the hernia must be proved by an examination made within forty-eight hours.

(2) It must be proved that the hernia appeared suddenly.

(3) It must appear immediately after the accident and be accompanied by pain.

(4) Proof must be furnished that the hernia did not exist prior to the accident.

In the case presented all the above conditions are fulfilled.

This case illustrates the fact that considerable damage may occur to tissues without commensurate skin damage.

Furthermore, in similar cases it would be wiser to defer surgery for several weeks until tissue vitality is restored.

Thanks are due to Dr. Carl B. Burdick, Director of the Fourth Surgical Division of Bellevue Hospital, for his courtesy in allowing this case to be presented.

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PERSISTING OBLITERATED OMPHALO-ENTERIC DUCT WITH MECKEL'S DIVERTICULUM AS A CAUSE OF ACUTE INTESTINAL OBSTRUCTION

CASES of bowel obstruction by a persisting cord-like remnant of the omphalo-enteric duct, while by no means rare in the literature, are sufficiently uncommon in the clinical experience of the average general surgeon to warrant, I believe, a brief description of the condition, and the recording of two additional cases.

The ductus-omphalo-entericus, during the first three weeks of embryonic development, connects the lumen of the intestine with the yolk sac (in man a structure comparable to the yolk sac: a "yolkless" yolk sac). Normally, this communication becomes obliterated by the end of the second month; somewhat later, the cord, representing the obliterated duct, disappears. In 2 per cent. of cases it remains patent at the proximal end as the well-known Meckel's diverticulum. In a decidedly smaller number of cases the duct will persist as an obliterated cord running from the fundus or the side of a Meckel's diverticulum to the umbilicus. In comparatively rare instances this cord will become freed from its umbilical attachment and either float free in

the abdominal cavity or more commonly become attached elsewhere in the abdomen.

It is by this last-named variety, according to Treves, that constriction of the bowel is most often effected. "Certainly," he says, "in nearly all reported instances of strangulation under a diverticulum, the process has been adherent to a point other than the vicinity of the umbilicus."

Both cases I am herein reporting fall into this last category. It is interesting that both of these cases were referred by the same physician, Dr. D. Staneff, within a period of less than two months.

CASE I.—Miss L. G., aged twenty-two, entered the hospital on March 28, 1930, complaining of abdominal pain and vomiting. The pain began the previous evening, was cramp-like and intermittent in character, beginning in the region of the umbilicus, but seemed later to change to the lower left quadrant of the abdomen. She vomited
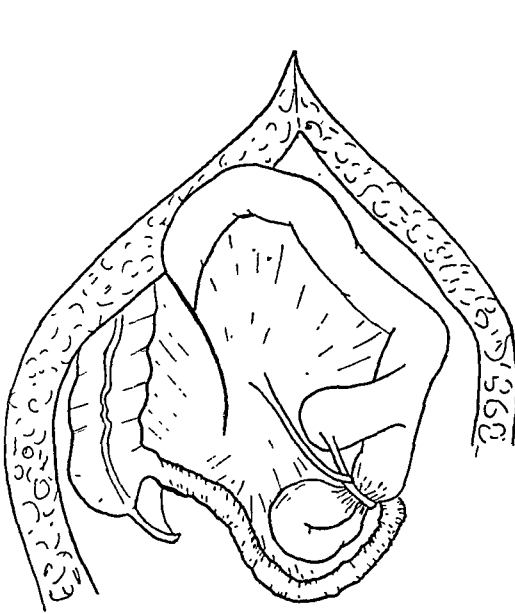
FIG. 1.—Case I. Intestinal obstruction from persistent obliterated omphalo-enteric duct.
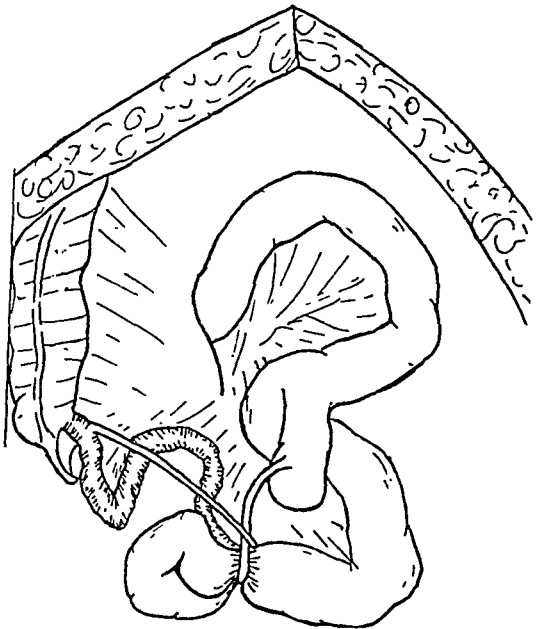
FIG. 2.—Case II. Intestinal obstruction from persistent obliterated omphalo-enteric duct.

frequently from the onset. On admission, her temperature was 100°, pulse 96, respirations 24, the white blood-cell count was 12,400, and the urine was entirely negative. There had been no movement of the bowels and no flatus expelled since the onset.

Examination revealed a well-developed white female, seemingly in severe pain of a paroxysmal type. Her color was good and she did not appear acutely ill. There was no definite rigidity of the abdominal muscles, though some resistance below the navel was evident. Tenderness and resistance were most marked in the lower left quadrant. There was a slight bloody vaginal discharge (her regular menstrual period had begun four days previously). Rectal examination revealed no definite mass in the pelvis and the uterus seemed normal. A small clear water enema was given which returned clear, with no flatus.

The abdomen was opened without further delay, revealing markedly distended coils of small intestine. These were followed systematically in the usual way to a point over the promontory of the sacrum and a little to the left. Here a loop of small intestine was found totally obstructed in a "snare" formed by a round smooth cord looped on

itself; the intestine beyond was collapsed. Severing this cord freed the obstruction. It was then found to run from the lateral surface of a Meckel's diverticulum to a point at the root of the small bowel mesentery where it was firmly adherent. I have tried to represent this in a semi-diagrammatic drawing (Fig. 1).

Dr. E. R. Long, of the Department of Pathology of the University of Chicago, returned the following pathological report:

"The specimen has the typical shape of a Meckel's diverticulum. The distal end is thickened, and a thin cord of tissue extends from it (apparently the remains of the omphalo-mesenteric duct). *Microscopic.*—The mucosa is normal except for some infiltration of eosinophiles. The submucosa is thickened by fibrosis and œdema."

This patient made an uneventful recovery and is symptom-free at the time of this writing.

CASE II.—Mr. P. O., aged fifty-six, a laborer. Obstruction symptoms had been present for four full days before a physician was called. Fæcal vomiting was already present on admission to the hospital, May 27, 1930. He was operated upon shortly after admission and died on the following day.

The findings were similar to those in Case I, with the exception that while in Case I the cord-like structure causing the obstruction extended from a Meckel's diverticulum to attach at the root of the mesentery of the small intestine, in this case (see Fig. 2) the distal end had become freed from its umbilical attachment and had fastened itself to the anti-mesenteric surface of the ileum at a point about two centimetres from the ileocæcal juncture. The mechanics of the strangulation in each case were those described by Treves as "obstruction by snaring."

The pathological report returned by Dr. Paul R. Cannon, of the Department of Pathology of the University of Chicago, follows: "The specimen consists of a Meckel's diverticulum and a fibrous cord about two millimetres in diameter. Sections through the diverticulum show œdema of the wall and infiltration by polymorphonuclear leucocytes. A cross-section of the fibrous cord shows a large, thick-walled artery and a smaller vein. The wall of the artery is hyalinized and greatly thickened. Around the vessels is a fibrous connective tissue, but no duct is present.

Diagnosis.—Meckel's diverticulum, showing acute enteritis; obliterated omphalo-mesenteric duct.

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RECOVERY FROM FRACTURE OF THE NECK OF THE FEMUR IN A NONAGENARIAN *

THE abduction method of treatment of fracture of the neck of the femur described by Whitman is so widely accepted as the best non-operative procedure that further contributions may seem quite unnecessary. But a few years ago the restoration of form and function in such cases was taught as an object rarely to be expected or even sought. The danger to life in weak and aged patients was considered such as to forbid the treatment in the plaster case.

The opportunities to observe and record the results of active treatment of this condition in patients over ninety years of age are rare indeed. According to the American experience tables of mortality for persons ninety-three years of age there were records of seventy-nine persons and of these fifty-eight died during the year giving a death rate of seven hundred thirty-four per thousand and an average expectancy of nine and one-half months. This brief expectancy may raise an economic question but one who has observed the immediate relief from suffering which occurs when the fracture is properly reduced and treated by the abduction method is apt to become an advocate of the treatment in the most hopeless cases. The case I now report is that of a ninety-three-year-old woman who was treated by the artificial impaction method of Cotton with Whitman abduction in a plaster case.

Mrs. A. B., ninety-three years of age in August, 1928, while entering a store through a revolving door stumbled and fell to the floor November 23, 1928. When I saw her immediately thereafter she was sitting in a chair unable to use the left lower extremity and complaining of pain in the left hip region. She was immediately placed in an ambulance and taken to the Asbury Hospital. She weighed about eighty-five pounds. She appeared very old and frail. Her eyesight was very much diminished. There was a large adenomatous goitre present. Blood pressure was one hundred thirty systolic and eighty diastolic. The urine was normal. The physical examination was otherwise normal. The past history was not important. The röntgenogram showed an intracapsular fracture of the neck of the left femur with the distal fragment displaced upward about one inch and rotated outward. (Fig. 1.)

Treatment for the first four days consisted of rest in bed with the extremity supported as well as possible with sandbags on each side of the thigh and leg. During this time she suffered a great deal of pain and was very difficult to care for, but she rallied from the shock and presented a somewhat encouraging appearance. On the fourth day she was taken to the operating room and placed on a Hawley table and given a general anæsthetic and the fracture was reduced in the usual manner. In order to be certain that the fracture was reduced before instituting further treatment a portable X-ray machine was moved into the operating room and an exposure was made showing the fractured bones in perfect position. (Fig. 2.) Felt pads were then placed over the greater trochanter and an artificial impaction was performed according to the method of Cotton. A plaster case was then applied from the nipple line to the toes with the limb in abduction and internal rotation. Fig. 3 shows the position in the plaster case and illustrates the impaction when compared with Fig. 2.

* From the University of Minnesota Medical School.

FIG. 1.—Röntgenogram of ninety-three-year-old woman taken on day of injury showing intracapsular fracture of the neck of the left femur with the distal fragment displaced upward about one inch and rotated outward as indicated by the prominence of the lesser trochanter.
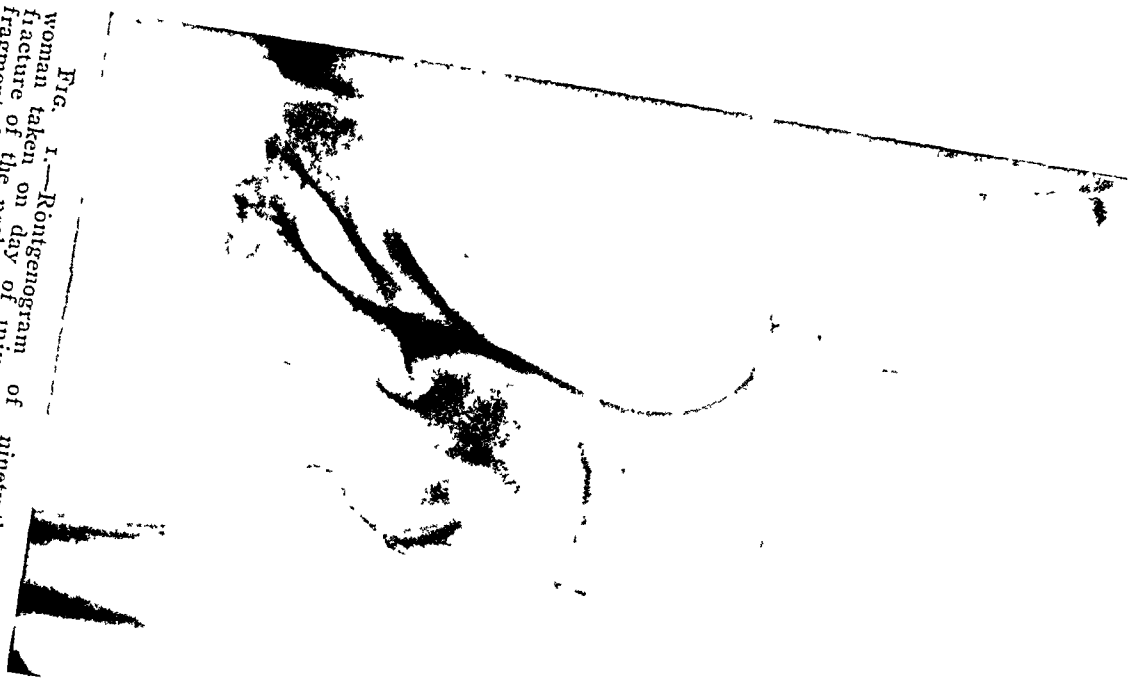
FIG. 2.—Röntgenogram taken with portable apparatus while patient is under general anæsthesia on Hawley fracture table after reduction of the intracapsular fracture but before artificial impaction of the fragments and the perfect apposition has been performed. Note of the femur as evidenced by the inversion pearance of the lesser trochanter... lete disap-
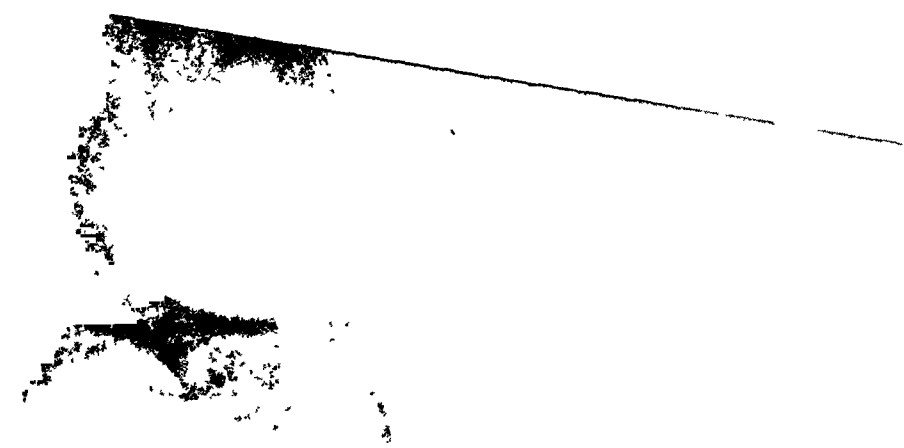
FIG. 3.—Röntgenogram taken four months after injury and one month after removal of the plaster case. Note the absence of absorption of the femoral neck. The femur is in the position of abduction. Note the normal position of the lesser trochanter.
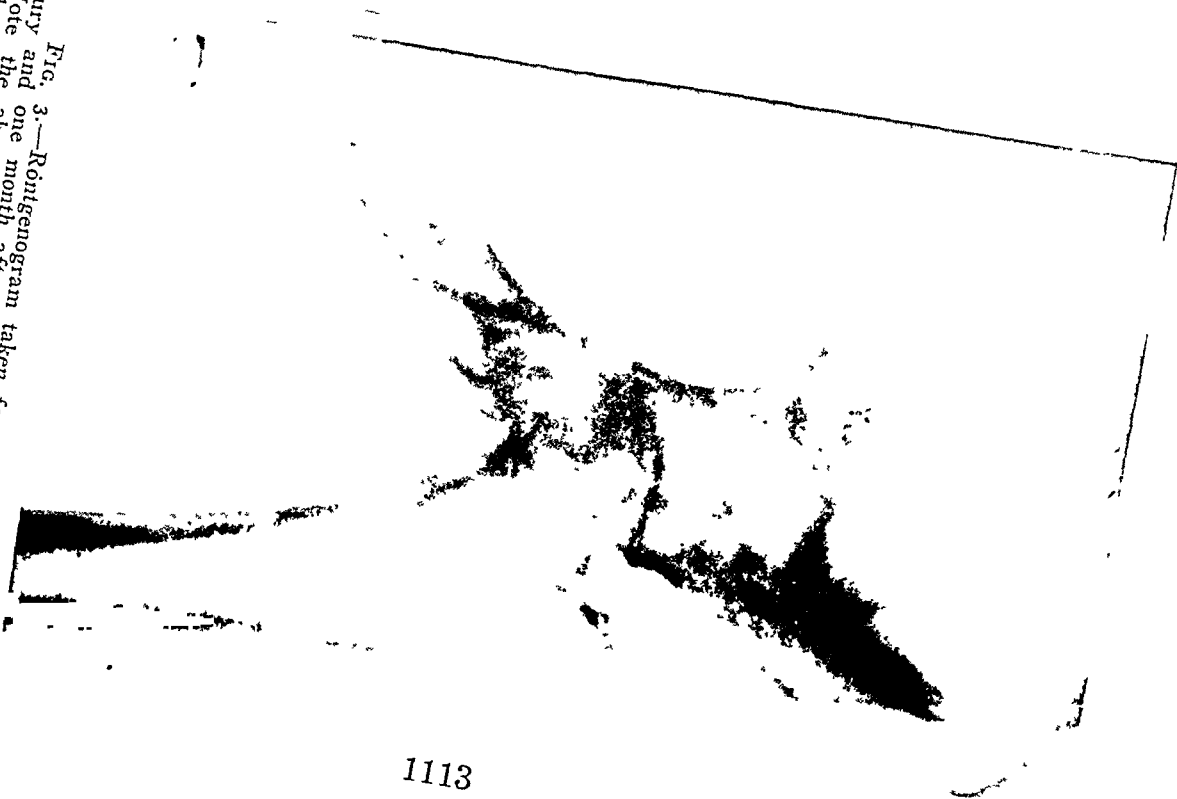
Immediately upon recovery from the anæsthetic she remarked upon the absence of pain in the hip and continued to speak of the absence of pain in the hip to all visitors. The usual after care was given consisting of turning her over on her abdomen for one hour three times daily and raising the head of her bed and later getting her about in the case in a wheel chair.

One month after injury she developed a slight respiratory infection and began to eat very poorly and her blood pressure dropped from one hundred thirty systolic to one hundred in a few days. She was given a daily eggnog containing one half ounce of brandy during the next two months and her progress was thereafter uneventful.

The plaster case was removed February 26, 1929, three months after injury. She was kept in bed for an additional month. At the end of four months röntgenograms taken in abduction and adduction (Fig. 3) showed that the fracture was in perfect position and the head rotated with the neck of the femur.

She was supplied with a walking caliper brace and crutches and was taught to walk a little and was returned to the home for the aged. During the next three months she was taken outside for daily fresh air and was encouraged as much as possible but she gradually failed and died seven months and one week after receiving the injury.

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THE REHFUSS TUBE IN GASTRIC SURGERY

HAVING observed with what advantage Dr. J. M. T. Finney has employed the Rehfuss tube in gastroenterostomies, pyloroplasties and in Polya anastomoses following gastric resections, it has caused me to wonder why its use in such instances is not more popular. Therefore, an addition to the Rehfuss tube is here described, which allows for the method a degree of dependability, convenience and exactness not otherwise obtainable and in addition the comfort of the patient is in no manner compromised.

The method consists, briefly, of bringing the upper end of the Rehfuss tube out through the nose after the metal olive has been swallowed.

The use of the Rehfuss tube alone, as applied by Doctor Finney, is briefly as follows: After the special gastric pre-operative preparation of the patient a sterile regular Rehfuss tube is swallowed before the patient goes to the operating room. The end of the tube protruding from the mouth is fastened to side of cheek with adhesive. A final aspiration may be made to insure an empty stomach. If on opening the stomach at operation it is found to be filled with regurgitated or secreted fluid, an attendant may aspirate the stomach from above before the operator proceeds, thus maintaining a clean operating field. During the anastomosis the metal olive is pulled through the new stoma just before the anterior row of sutures is taken, and placed about ten centimetres into the distal loop of intestine forming the anastomosis.

The advantage of such a procedure in post-operative care is obvious. Murphy drip may be connected up to the Rehfuss tube at once and fluids begun, using a 10 to 20 per cent. glucose at the start and adding other liquid nourishment as soon as the patient will tolerate it. The intake of fluids and

nourishment, in this manner, is deposited directly into the upper intestinal tract and beyond the site of anastomosis, thus sparing the stomach and anastomosis site of digestive functions. Adequate fluids and nourishment are absorbed in the normal physiological manner and in the great majority of instances the patient is spared all intravenous therapy, which is especially advantageous in eliminating the added trauma from repeated use of the
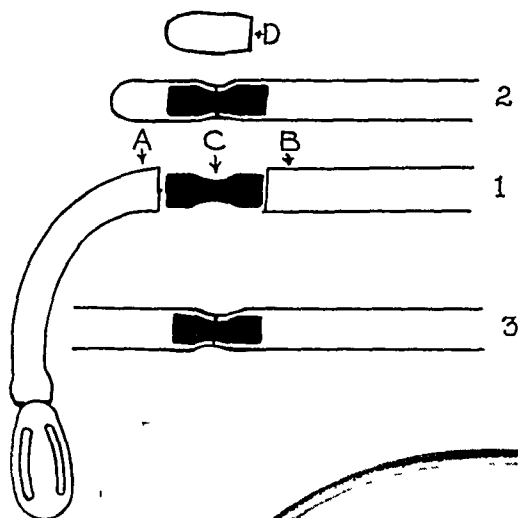
FIG. 1.—Diagram showing the four parts of the apparatus in the various combinations used in the procedure. A—Rehfuss duodenal tube. B—Rubber tubing, same as in Rehfuss tube. C—Solid metal connection. D—Rubber tip, closed at one end. Same size as tubing. (1) All parts disconnected. (2) B, C, D assembled to introduce through nose. A has been swallowed so that metal olive is in stomach. (3) Rubber tip removed from 2; A connected; ready to be pulled through nose.
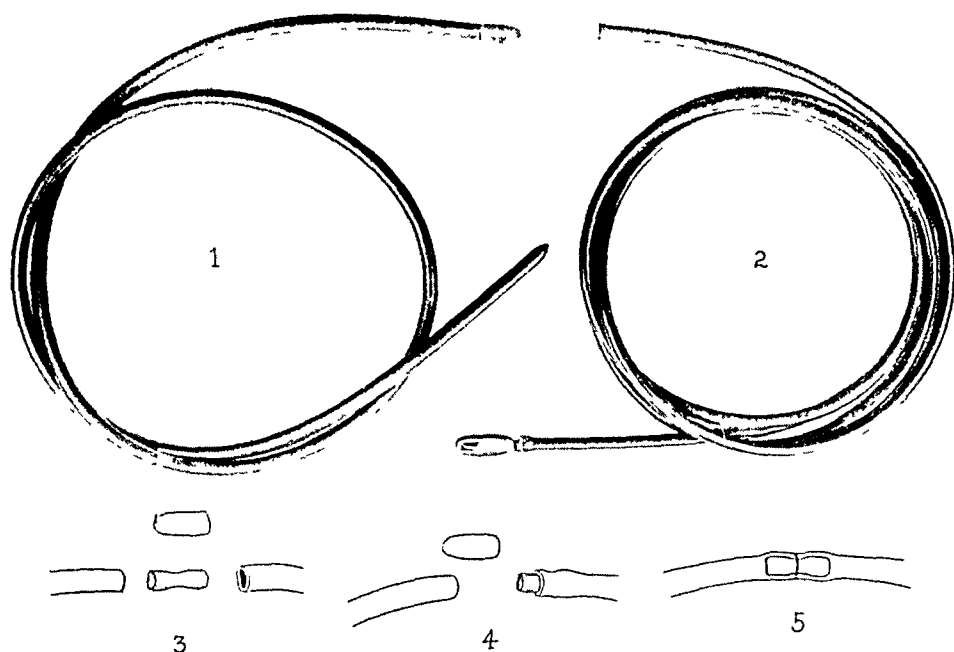
FIG. 2.—(1) Nasal tube with rubber tip attached to the metal connection, as represented in 2 of FIG. 1, ready for insertion through nose. (2) Rehfuss tube. (3) The ends of both tubes, the metal connection, and rubber tip dissembled, showing all the parts of the apparatus. (4) Rubber tip removed after end of nasal tube has been pulled out from pharynx through mouth. (5) End of Rehfuss tube attached to nasal tube, ready to be drawn through nose.

hypodermoclysis and vena puncture needle after an operation accompanied by more or less surgical shock.

Should excessive and irritating fluids accumulate in the remainder of the stomach or anastomosed loop of jejunum, these may be aspirated through the tube at any time post-operative.

The one objection with the Rehfuss tube alone is that it must protrude from the mouth, which is uncomfortable and a source of annoyance for the several days that it is desirable to keep the tube in place. Also, the tube

may be easily pulled out of the stomach unconsciously by the play of the patient's tongue upon it or accidentally by attendants prior to or after operation. Unable to find a suitable contrivance on the market that would allow one to bring the upper end of tube out through the nose, a simple apparatus has been made by the Hamilton-Schmidt Surgical Company at my suggestion which is pictured and described herewith.

By this method of bringing the upper end of the tube out through the nose, it is anchored securely in its proper position by means of its passage through the nares and allows far more comfort to the patient. It is hoped that by this means the objections to the procedure will thus be eliminated and allow for its more popular and dependable use.

Referring to the diagram of Fig. 1, the metal olive and tube of the Rehfuss tube, A, are swallowed by the patient until the proper length has passed into the œsophagus to permit the olive to lie in the stomach. The assembled tube, 2, is then passed into nose and the tip is grasped by a pair of forceps in the pharynx and pulled through the mouth. The rubber tip, D, is removed and the free end of A is attached to the metal connection, making a smooth continuity of tubing. Unit 3 is then pulled out through the nose until the Rehfuss tube passes directly

FIG. 3.—(1) Shows the Rehfuss tube in place. The nasal tube, with its special tip as described, has been passed into the pharynx. From here it has been pulled out through the mouth by grasping it with a hæmostat while depressing the tongue. Then the tip is removed as in 4 of FIG. 2 and the two ends joined as in 5 of FIG. 2. Then the upper end of the nasal tube is pulled out until the end of the Rehfuss tube protrudes from the nose. All parts are then disconnected and we have ready for use a Rehfuss tube passing through the nose with the metal olive lying in the stomach. (2) Shows the end of Rehfuss tube with metal olive pulled through the anastomosis opening and placed well within the distal loop of anastomosed intestine before anterior row of sutures is taken.

from œsophagus, through pharynx, and out the nose. Then all accessory parts are removed, leaving the free end of the Rehfuss tube protruding from the nose, in which position it is allowed to remain until its removal.

Removal is easily accomplished by grasping the portion of tube in the pharynx with a forceps and pulling both the nasal and œsophageal portions of tube out through the mouth by one procedure.

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MEMOIRS

HENRY BEECKMAN DELATOUR

1866–1930

HENRY BEECKMAN DELATOUR died August 23, 1930, in the American Hospital, in Paris. Having been taken ill while in Vichy, Austria, he was removed to the hospital in Paris, where, after an illness of three weeks,

HENRY BEECKMAN DELATOUR

he died in his sixty-fifth year, having been born in the city of New York, March 27, 1866.

He was educated in the humanities in the College of the City of New

York and received his medical degree from the College of Physicians and Surgeons of Columbia University, in 1887. He was elected a Fellow of the American Surgical Association in 1910.

Immediately after his graduation in medicine in 1887, he was appointed an interne in the Seney-Methodist Hospital in Brooklyn, which was then being organized. He was, thus, the first house surgeon of that hospital, to which he gave enthusiastic work in the organization of the active and progressive surgical service which characterized it. Shortly after the completion of his interneship, a vacancy having occurred in the position of Assistant Surgeon to the hospital in the service of Dr. George R. Fowler, Doctor Delatour was appointed to fill the vacancy, and at once entered upon independent active and important surgical work which ended only with his death, over forty years later. In 1891, upon the organization of the Norwegian Hospital in Brooklyn, he was appointed one of the attending surgeons of that institution and continued to labor there up to the time of his death. In 1896, he was appointed one of the attending surgeons at St. John's Hospital, to which institution he also continued to give service throughout the remainder of his life. During later years his activities were especially devoted to promoting the welfare of St. John's Hospital, in which he not only filled the important positions of Chief of Staff and Senior Attending Surgeon, but was also a member of the board of managers, in the Executive and Building Committees of which he was very active, and more particularly during the development of plans for a new hospital, his experience, his labors and his studies made his advice invaluable. His surgical activities were not confined to the hospitals already mentioned; he also served as the head of the surgical staff of the Jewish Hospital from 1906 to 1912, and to the Long Island College Hospital during the period between 1896 and 1906 he was an attending surgeon and clinical professor of surgery. During the World War, Doctor Delatour held the rank of major in the Medical Reserve Corps and was in charge of the surgical service at Camp Upton. From 1904 to 1912 he was chief of the ambulance service of the city of Brooklyn.

In 1895 he married Miss Jeannie May Peck, of Brooklyn. There were no children from this union. His residence and private office were at 75 Eighth Avenue, Brooklyn.

Doctor Delatour was, above all, a clinician. His judgment, his talents and his ambitions were devoted to relief of the actual suffering which came within his personal view. His energies were so fully occupied by this practical work that no time was left for the research laboratory or for the literary labors of authorship. His personality was most pleasing. No one came in contact with him without being impressed by his genuineness, the solidity and scope of his attainments and the enterprise and capacity of his labors.

L. S. P.

ALBERT VANDER VEER

1841–1930

ALBERT VANDER VEER, of Albany, New York, was born in Root, Montgomery County, New York, July 10, 1841, the son of Abraham H. Vander Veer and Sarah Martin, his wife. The Vander Veer family in America traces its origin to Cornelise Janse Vander Veer, who emigrated

ALBERT VANDER VEER

from Alkmaar, Holland, in February, 1659, and settled on Long Island. The Revolutionary battle of Long Island of 1776 was partly fought on the Vander Veer farm. Members of the family moved from Long Island to New Jersey and from there in 1783 Jacob Vander Veer moved to the Mohawk Valley. His descendant, Albert, the subject of this sketch, after receiving his earlier education in the public schools of his vicinity, entered the Albany Medical College in 1861. Later, he transferred to the Medical Department of Colum-

bia University in Washington, D. C., from which institution he was graduated in January, 1863.

In the early part of the Civil War, in May, 1862, he was appointed a Medical Cadet in the Medical Corps of the United States Army and was assigned to a hospital in Washington which enabled him to continue his medical studies at the Columbia University as already stated. In December, 1862, he was commissioned Assistant Surgeon of the 66th New York Volunteers. His subsequent military record up to the close of the war was a distinguished one. In June, 1864, he was promoted to be Surgeon with the rank of Major and appointed one of the operating surgeons of the First Division of the Second Army Corps. He remained with the First Division in all its battles after the first Fredericksburg to the surrender of Appomattox. He was mustered out of the service in September, 1865.

His return to civil life was followed by post-graduate work in New York City and in Europe. He received the honorary degree of M.D. from the Albany Medical College in 1869; the degree of A.M. from Williams College in 1882; the degree of LL.D. from George Washington University in 1904.

Doctor Vander Veer had many medical, business and social connections. He was an ex-president of the American Medical Association and of the American Surgical Association. He was a member of the Loyal Legion and of the Grand Army of the Republic. From 1895 to the date of his death, in 1930, he was a member of the Board of Regents of the University of the State of New York of which he became the Chancellor in 1921. In 1868 Doctor Vander Veer was appointed an Attending Surgeon of the Albany Hospital of which institution he was made Surgeon-in-Chief in 1904. He was professor of anatomy in the Albany Medical College from 1877 to 1882; professor of surgery from 1882 to 1914.

Doctor Vander Veer became a resident of Albany in 1860 and practiced medicine and surgery in that city for over fifty years. He was generally recognized as one of the most distinguished members of the medical profession in the State of New York. He left two sons, Edgar Albert and James Newell, both of whom continue the work of their father in surgery and occupy conspicuous positions in their profession.

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